

This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`



Journal and proceedings of the Royal Society of New South Wales

Royal Society of New South Wales

Digitized by Google

Roy
6556

HARVARD UNIVERSITY.

LIBRARY

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY.

6671

Exchange

October 11, 1899.

Digitized by Google

Digitized by Google

Digitized by Google

218.2

OCT 11 1899

JOURNAL AND PROCEEDINGS

6671

OF THE

ROYAL SOCIETY

OF

NEW SOUTH WALES,

EDITED BY

THE HONORARY SECRETARIES.

THE AUTHORS OF PAPERS ARE ALONE RESPONSIBLE FOR THE OPINIONS EXPRESSED THEREIN.

PUBLISHED BY THE SOCIETY, 5 ELIZABETH STREET NORTH, SYDNEY.
LONDON AGENTS:
GEORGE ROBERTSON & Co.,
17 WARWICK SQUARE, PATERNOSTER ROW, LONDON, E.C.
1899.

Digitized by Google

CONTENTS.

VOLUME XXXII.

	Page.
Officers for 1898-99	(vii.)
List of Members, &c.	(ix.)
Art. I.—President's Address. By Henry Deane, M.A., M. Inst. C.E.	1
Art. II.—Aeronautics. By L. Hargrave	55
Art. III.—Australian Divisional Systems. By R. H. Mathews, L.S.	66
Art. IV.—Artesian Water in New South Wales. By J. W. Boultbee	88
Art. V.—On the "Stringybark" Trees of N. S. Wales, especially in regard to their Essential Oils. By R. T. Baker, F.L.S., Curator, and H. G. Smith, F.C.S., Technological Museum, Sydney	104
Art. VI.—Current Observations on the Canadian-Australian Route. By Capt. M. W. Campbell Hepworth, F. R. Met. Soc., F.R.A.S., R.M.S. *Aorangi*. (Communicated by Mr. H. C. Russell, B.A., C.M.G., F.R.S.)	120
Art. VII.—Water-spouts on the Coast of New South Wales. By H. C. Russell, B.A., C.M.G., F.R.S. (*Plates* ii.-ix.)... ...	132
Art. VIII.—Some Physical Properties of Nickel Steel. By W. H. Warren, Wh. Sc., M. Inst. C.E., M. Am. Soc. C.E., Challis Professor of Engineering, and S. H. Barraclough, M.M.E., Assoc. M. Inst. C.E., Lecturer in Engineering, University of Sydney	150
Art. IX.—Key to the Tribes and Genera of Melanospermeæ, (Olive-Green Seaweeds). By Richard A. Bastow, Fitzroy, Victoria. (Communicated by J. H. Maiden, F.L.S.) (*Plate* i.)	169
Art. X.—Etude sur les Dialectes de la Nouvelle-Calédonie. Par Julien Bernier. (Communicated by C. Hedley, F.L.S.) ...	173
Art. XI.—On the Pinenes of the Oils of the Genus Eucalyptus, Part I. By Henry G. Smith, F.C.S., Technological Museum, Sydney	195
Art. XII.—Soaring Machines. By L. Hargrave	209
Art. XIII.—Native Vocabulary of Miscellaneous New South Wales Objects. By Mr. Surveyor Larmer. (Communicated by Professor T. P. Anderson Stuart, M.D., by permission of the Honourable the Secretary for Lands	223
Art. XIV.—Current Papers, No. 3. By H. C. Russell, B.A., C.M.G. F.R.S. (*Plates* x., xi.)	230
Art. XV.—The Group Divisions and Initiation Ceremonies of the Barkunjee Tribes. By R. H. Mathews, L.S. (*Plate* xii.)...	241

Digitized by Google

JOURNAL

AND

PROCEEDINGS

OF THE

ROYAL SOCIETY

OF

NEW SOUTH WALES

FOR

1898.

(INCORPORATED 1881.)

VOL. XXXII.

EDITED BY

THE HONORARY SECRETARIES.

THE AUTHORS OF PAPERS ARE ALONE RESPONSIBLE FOR THE STATEMENTS MADE AND THE OPINIONS EXPRESSED THEREIN.

PUBLISHED BY THE SOCIETY, 5 ELIZABETH STREET NORTH, SYDNEY.
LONDON AGENTS:
GEORGE ROBERTSON & Co.,
17 WARWICK SQUARE, PATERNOSTER ROW, LONDON, E.C.
1898.

Digitized by Google

Digitized by Google

NOTICE.

THE ROYAL SOCIETY of New South Wales originated in 1821 as the "Philosophical Society of Australasia"; after an interval of inactivity, it was resuscitated in 1850, under the name of the "Australian Philosophical Society," by which title it was known until 1856, when the name was changed to the "Philosophical Society of New South Wales"; in 1866, by the sanction of Her Most Gracious Majesty the Queen, it assumed its present title, and was incorporated by Act of the Parliament of New South Wales in 1881.

NOTICE TO AUTHORS.

The Honorary Secretaries request that authors of papers requiring illustrations by zinco-type or photo-lithographic process, will, before preparing drawings, make application to the Assistant Secretary for patterns of the standard sizes of diagrams etc. to suit the Society's Journal.

NOTICE.

The Society's Journal for 1898, Vol. XXXII., has been forwarded to the same Societies and Institutions as enumerated on the printed list in Vol. XXX. (viz. 400), with the addition of the Field Columbian Museum, Chicago; Royal Society of Sciences and Belles Lettres, Gothenburg, and The Editor of *Science Abstracts*, London.

It is requested that the volume may be acknowledged by returning the Form of Receipt (to be found stitched in the commencement of the volume) signed and dated in order that any delay or mis delivery may be brought to notice.

ERRATA.

On page 205 "On the Pinenes of the oils of the genus Eucalyptus," lines 14 and 16 from top, for "terpene," read "*terpin*"; line 15 from top for "terpenes," read "*terpins*."

Page 73, footnote 1, for "XIII." read "XVIII.,"

,, 78, line 7, for "list," read "*lists*."

,, 82, line 6, for "pronounciation," read "*pronunciation*."

Digitized by Google

PUBLICATIONS.

———o———

Transactions of the Philosophical Society, N.S.W., 1862-5, pp. 374, out of print.

Vol.	I.	Transactions of the Royal Society, N.S.W.,					1867, pp. 83,	,,
,,	II.	,,	,,	,,	,,	,,	1868, ,, 120,	,,
,,	III.	,,	,,	,,	,,	,,	1869, ,, 173,	,,
,,	IV.	,,	,,	,,	,,	,,	1870, ,, 106,	,,
,,	V.	,,	,,	,,	,,	,,	1871, ,, 72,	,,
,,	VI.	,,	,,	,,	,,	,,	1872, ,, 123,	,,
,,	VII.	,,	,,	,,	,,	,,	1873, ,, 182,	,,
,,	VIII.	,,	,,	,,	,,	,,	1874, ,, 116,	,,
,,	IX.	,,	,,	,,	,,	,,	1875, ,, 235,	,,
,,	X.	Journal and Proceedings			,,	,,	1876, ,, 333,	,,
,,	XI.	,,	,,	,,	,,	,,	1877, ,, 305,	,,
,,	XII.	,,	,,	,,	,,	,,	1878, ,, 324,	price 10s. 6d.
,,	XIII.	,,	,,	,,	,,	,,	1879, ,, 255,	,, 10s. 6d.
,,	XIV.	,,	,,	,,	,,	,,	1880, ,, 391,	,, 10s. 6d.
,,	XV.	,,	,,	,,	,,	,,	1881, ,, 440,	,, 10s. 6d.
,,	XVI.	,,	,,	,,	,,	,,	1882, ,, 327,	,, 10s. 6d.
,,	XVII.	,,	,,	,,	,,	,,	1883, ,, 324,	,, 10s. 6d.
,,	XVIII.	,,	,,	,,	,,	,,	1884, ,, 224,	,, 10s. 6d.
,,	XIX.	,,	,,	,,	,,	,,	1885, ,, 240,	,, 10s. 6d.
,,	XX.	,,	,,	,,	,,	,,	1886, ,, 396,	,, 10s. 6d.
,,	XXI.	,,	,,	,,	,,	,,	1887, ,, 296,	,, 10s. 6d.
,,	XXII.	,,	,,	,,	,,	,,	1888, ,, 390.	,, 10s. 6d.
,,	XXIII.	,,	,,	,,	,,	,,	1889, ,, 534,	,, 10s. 6d.
,,	XXIV.	,,	,,	,,	,,	,,	1890, ,, 290,	,, 10s. 6d.
,,	XXV.	,,	,,	,,	,,	,,	1891, ,, 348,	,, 10s. 6d.
,,	XXVI.	,,	,,	,,	,,	,,	1892, ,, 426,	,, 10s. 6d.
,,	XXVII.	,,	,,	,,	,,	,,	1893, ,, 530,	,, 10s. 6d.
,,	XXVIII.	,,	,,	,,	,,	,,	1894, ,, 368,	,, 10s. 6d.
,,	XXIX.	,,	,,	,,	,,	,,	1895, ,, 600,	,, 10s. 6d.
,,	XXX.	,,	,,	,,	,,	,,	1896, ,, 568,	,, 10s. 6d.
,,	XXXI.	,,	,,	,,	,,	,,	1897, ,, 626,	,, 10s. 6d.
,,	XXXII.	,,	,,	,,	,,	,,	1898, ,, 476,	,, 10s. 6d.

Digitized by Google

CONTENTS.

VOLUME XXXII.

	Page.
Officers for 1898-99	(vii.)
List of Members, &c.	(ix.)
Art. I.—President's Address. By Henry Deane, M.A., M. Inst. C.E.	1
Art. II.—"Aeronautics." By L. Hargrave	55
Art. III.—Australian Divisional Systems. By R. H. Mathews, L.S.	66
Art. IV.—Artesian Water in New South Wales. By J. W. Boultbee	88
Art. V.—On the "Stringybark" Trees of N. S. Wales, especially in regard to their Essential Oils. By R. T. Baker, F.L.S., Curator, and H. G. Smith, F.C.S., Technological Museum, Sydney	104
Art. VI.—Current Observations on the Canadian-Australian Route. By Capt. M. W. Campbell Hepworth, F. R. Met. Soc., F.R.A.S., R.M.S. *Aorangi*. (Communicated by Mr. H. C. Russell, B.A., C.M.G., F.R.S.)	120
Art. VII.—Water-spouts on the Coast of New South Wales. By H. C. Russell, B.A., C.M.G., F.R.S. (*Plates* ii.-ix.)... ...	132
Art. VIII.—Some Physical Properties of Nickel Steel. By W. H. Warren, Wh. Sc., M. Inst. C.E., M. Am. Soc. C.E., Challis Professor of Engineering, and S. H. Barraclough, M.M.E., Assoc. M. Inst. C.E., Lecturer in Engineering, University of Sydney	150
Art. IX.—Key to the Tribes and Genera of Melanospermeæ, (Olive-Green Seaweeds). By Richard A. Bastow, Fitzroy, Victoria. (Communicated by J. H. Maiden, F.L.S.) (*Plate* i.)	169
Art. X.—Etude sur les Dialectes de la Nouvelle-Calédonie. Par Julien Bernier. (Communicated by C. Hedley, F.L.S.) ...	173
Art. XI.—On the Pinenes of the Oils of the Genus Eucalyptus, Part I. By Henry G. Smith, F.C.S., Technological Museum, Sydney	195
Art. XII.—Soaring Machines. By L. Hargrave	209
Art. XIII.—Native Vocabulary of Miscellaneous New South Wales Objects. By Mr. Surveyor Larmer. (Communicated by Professor T. P. Anderson Stuart, M.D., by permission of the Honourable the Secretary for Lands	223
Art. XIV.—Current Papers, No. 3. By H. C. Russell, B.A., C.M.G. F.R.S. (*Plates* x., xi.)	230
Art. XV.—The Group Divisions and Initiation Ceremonies of the Barkunjee Tribes. By R. H. Mathews, L.S. (*Plate* xii.)...	241

Digitized by Google

ART. XVI.—The Blue Pigment of Corals. By Professor Liversidge, M.A., LL.D., F.R.S.... 256
ART. XVII.—Annual Address to the Engineering Section. By T. H. Houghton, Assoc. M. Inst. C.E., M. Inst. M.E. I.
ART. XVIII.—The Narrow Gauge as applied to Branch Railways in N.S. Wales. By C. O. Burge, M. Inst. C.E. XXII.
ART. XIX.—Engineering Construction in connection with Rainfall. By J. I. Haycroft, M. Inst. C.E. I., Assoc. M. Am. Soc. C.E. ... XXXIII.
ART. XX.—Some Notes on a Wharf recently built in deep water at Dawes' Point, Sydney, N. S. Wales. By Norman Selfe, M. Inst. C.E., &c. LXIV.
ART. XXI.—Notes on Hydraulic Boring Apparatus. By G. H. Halligan, C.E. LXXII.
ART. XXII.—Lighthouses in N. S. Wales. By H. R. Carleton, M. Inst. C.E. LXXXII.
ART. XXIII.—A Testing Machine for equal alternating stresses. By Professor Warren, Wh. Sc., M. Inst. C.E. CVIII.
ABSTRACT OF PROCEEDINGS i.
PROCEEDINGS OF THE ENGINEERING SECTION... lx.
PROCEEDINGS OF THE MEDICAL SECTION lxiv.
INDEX TO VOLUME XXXII. (xxvii.)

Digitized by Google

Royal Society of New South Wales.

OFFICERS FOR 1898-99.

Honorary President:
HIS EXCELLENCY THE RIGHT HON. HENRY ROBERT VISCOUNT HAMPDEN.

President:
G. H. KNIBBS, F.R.A.S.

Vice-Presidents:

PROF. ANDERSON STUART, M.D.	PROF. T. W. E. DAVID, B.A., F.G.S.
PROF. THRELFALL, M.A.	HENRY DEANE, M.A., M. Inst. C.E.

Hon. Treasurer:
H. G. A. WRIGHT, M.R.C.S. *Eng.*, L.S.A. *Lond.*

Hon. Secretaries:

J. H. MAIDEN, F.L.S.	W. M. HAMLET, F.C.S., F.I.C.

Members of Council:

C. O. BURGE, M. Inst. C.E.	CHARLES MOORE, F.L.S.
E. B. DOCKER, M.A., D.C.J.	E. F. PITTMAN, Assoc. R.S.M.
J. W. GRIMSHAW, M. Inst. C.E.	F. H. QUAIFE, M.A., M.D.
H. A. LENEHAN, F.R.A.S.	H. C. RUSSELL, B.A., C.M.G., F.R.S.
Prof. LIVERSIDGE, M.A., LL.D., F.R.S.	PROF. WARREN, M. Inst. C.E., Wh.Sc.

Assistant Secretary:
W. H. WEBB.

Digitized by Google

FORM OF BEQUEST.

I bequeath the sum of £ to the ROYAL SOCIETY OF NEW SOUTH WALES, Incorporated by Act of the Parliament of New South Wales in 1881, and I declare that the receipt of the Treasurer for the time being of the said Corporation shall be an effectual discharge for the said Bequest, which I direct to be paid within calendar months after my decease, without any reduction whatsoever, whether on account of Legacy Duty thereon or otherwise, out of such part of my estate as may be lawfully applied for that purpose.

[*Those persons who feel disposed to benefit the Royal Society of New South Wales by Legacies are recommended to instruct their Solicitors to adopt the above Form of Bequest.*]

Digitized by Google

LIST OF THE MEMBERS

OF THE

Royal Society of New South Wales.

P Members who have contributed papers which have been published in the Society's Transactions or Journal; papers published in the Transactions of the Philosophical Society are also included. The numerals indicate the number of such contributions.

‡ Life Members.

Elected.		
1877		Abbott, The Hon. Sir Joseph Palmer, Knt., K.C.M.G., M.L.A., Speaker of the Legislative Assembly, Castlereagh-street.
1877	P 5	Abbott, W. E., 'Abbotsford,' Wingen.
1864		Adams, P. F., 'Casula,' Liverpool.
1895		Adams, J. H. M., Athenæum Club, p.r. Broughton Cottage, St. James' Road, Waverley.
1890	P 2	Allan, Percy, Assoc. M. Inst. C.E., Assoc. M. Am. Soc. C.E., Engineer-in-Charge of Bridge Design, Public Works Depart., Sydney.
1885		Allworth, Joseph Witter, District Surveyor, East Maitland.
1898		Alexander, Frank Lee, Cement Works, Druitt-street.
1877		Anderson, H. C. L., M.A., 161 Macquarie-street.
1896		Archer, Samuel, B.E. Roy. Univ. *Irel.*, Resident Engineer, Roads and Bridges Office, Mudgee.
1878		Backhouse, Alfred P., M.A., District Court Judge, 'Melita,' Elizabeth Bay.
1894	P 4	Baker, Richard Thomas, F.L.S., Curator, Technological Museum.
1894		‡Balsille, George, Sandymount, Dunedin, New Zealand.
1895	P 3	Bancroft, T. L., M.B. *Edin.*, Deception Bay, viâ Burpengary, Brisbane, Queensland.
1896		Barff, H. E., M.A., Registrar, Sydney University.
1895	P 5	Barraclough, S. H., B.E., M.M.E., Assoc. M. Inst. C.E., Lecturer in Engineering, Sydney University; p.r. 'Lansdown,' 30 Bayswater Road, Darlinghurst.
1876		Bassett, W. F., M.R.C.S. *Eng.*, George-street, Bathurst.
1894		Baxter, William Howe, Chief Surveyor Existing Lines Office, Railway Department; p.r. 'Hawerby,' Carrington Avenue, Strathfield.
1898		Beale, Charles Griffin 109 Pitt-street and Warrigal Club.
1877		Belfield, Algernon H., 'Eversleigh,' Dumaresq.
1875		Belisario, John, M.D., Lyons' Terrace, Hyde Park.
1876		Benbow, Clement A.. 263 Elizabeth-street.
1869	P 2	Bensusan, S L., 14 O'Connell-street, Box 411 G.P.O.
1895		Bensusan, A. J., A.R.S.M., F.C.S., Laboratory, 12 O'Connell-st.
1888		‡Blaxland, Walter, F.R.C.S. *Eng.*, L.R.C.P. *Lond.*, Mount Barker, South Australia.
1893		Blomfield, Charles E., B C.E. *Melb.*, Water Conservation Branch, Public Works Department, Sydney.

Digitized by Google

Elected		
1879		‡Bond, Albert, 131 Bell's Chambers, Pitt-street.
1897		Boucher, Arthur Sackville, M. Inst. C. E., Mining Engineer, Equitable Buildings.
1895	P 1	Boultbee, James W., Superintendent of Public Watering Places and Artesian Boring, Department of Mines and Agriculture.
1891		Bowman, Archer S. C.E., 'Turuwul,' Redmyre Road, Burwood.
1893		Bowman, John, C.E., Tramway Construction Branch, Public Works Department.
1893		Bowman, Reginald, M.B. et Ch. M. *Edin.*, 261 Elizabeth-street and George-street, Parramatta.
1876		Brady, Andrew John, Lic. K. & Q. Coll. Phys. *Irel.*, Lic. R. Coll. Sur. *Irel.*, 3 Lyons' Terrace, Hyde Park.
1891		Brennand, Henry J. W., B.A., Bank of New South Wales, Haymarket Branch, City.
1878		‡Brooks, Joseph, F.R.G.S., F.R.A.S., 'Hope Bank,' Nelson-street, Woollahra.
1896		Brown, Alexander, Newcastle.
1876		Brown, Henry Joseph, Solicitor, Newcastle.
1891		Bruce, John Leck, Technical College, Sydney.
1898		Burfitt, W. Fitzmaurice, B.A., B. Sc., 1 Hereford-st., Glebe Point.
1891	P 3	Burge, Charles Ormsby, M. Inst. C.E., Principal Assistant Engineer, Railway Construction, 'Fitz Johns,' Alfred-street N., North Sydney.
1890		Burne, Dr. Alfred, Dentist, 1 Lyons' Terrace, Liverpool-st.
1880		Bush, Thomas James, Engineer's Office, Australian Gas-Light Company, 163 Kent-street.
1876		Cadell, Alfred, Dalmorton.
1897		Callender, James Ormiston, Consulting Electrical Engineer, Equitable Buildings, George-street.
1894		Cameron, Alex. Mackenzie, Walgett.
1879		Campbell, Rev. Joseph, M.A., F.G.S., F.C.S., Te Aroha, Auckland, New Zealand.
1876		Cape, Alfred J., M.A. *Syd.*, 'Karoola,' Edgecliffe Road.
1897		Cardew, John Haydon, Assoc. M. Inst. C.E., L.S., 75 Pitt-street.
1894	P 1	Carleton, Henry R., M. Inst. C.E., 'Tarcoola,' Nelson-st. Woollahra.
1891		Carment, David, F.I.A. *Gt. Brit. & Irel.*, F.F.A. *Scot.*, Australian Mutual Provident Society, 87 Pitt-street.
1879	P 1	‡Chard, J. S., Licensed Surveyor, Armidale.
1878		Chisholm, Edwin, M.R.C.S. *Eng.*, L.S.A. *Lond.*, 82 Darlinghurst Road.
1885		Chisholm, William, M.D. *Lond.*, 139 Macquarie-street, North.
1888		Clubbe, C. P. B., L.R.C.P. *Lond.*, M.R.C.S. *Eng.*, 195 Macquarie-st.
1896		Cook, W. E., M.C.E. *Melb. Univ.*, M. Inst. C.E., District Engineer, Water and Sewerage Department, North Sydney.
1876		Codrington, John Frederick, M.R.C.S. *Eng.*, L.R.C.P. *Lond.*, L.R.C.P. *Edin.*, 'Holmsdale,' Chatswood.
1893		Cohen, Algernon A., M.B., M.D. *Aberd.*, M.R.C.S. *Eng.*, 71A Darlinghurst Road.
1886		Collingwood, David, M.D. *Lond.*, F.R.C.S. *Eng.*, 'Airedale,' Summer Hill.
1878		Colquhoun, George, Crown Solicitor, 'Rossdhu,' Belmore Road, Hurstville.

Digitized by Google

Elected		
1876		Colyer, J. U. C., Australian Gas-Light Co., 163 Kent-street.
1856		Comrie, James, 'Northfield,' Kurrajong Heights, viâ Richmond.
1882		Cornwell, Samuel, Australian Brewery, Bourke-st., Waterloo.
1891		Coutie, W. H., M.B., Ch. B. *Univ. Melb.*, 'Warminster,' Canterbury Road, Petersham.
1892	P 1	Cowdery, George R., Engineer for Tramways; p.r. 'Glencoe,' Torrington Road, Strathfield.
1880		Cox, The Hon. George Henry, M.L.C., Mudgee: and Warrigal Club, 145 Macquarie-st.
1886		Crago, W. H., M.R.C.S. *Eng.*, L.R.C.P. *Lond.*, 16 College-street, Hyde Park.
1869		Creed, The Hon. J. Mildred, M.L.C., M.R.C.S. *Eng.*, L.R.C.P. *Edin.*, 195 Elizabeth-street.
1870		Croudace, Thomas, Lambton.
1891	P 5	Curran, Rev. J. Milne, Lecturer in Geology, Technical College, Sydney.
1875		Dangar, Fred. H., c/o Messrs. Dangar, Gedye, & Co., Mercantile Bank Chambers, Margaret-street.
1890		Dare, Henry Harvey, M.E., Assoc. M. Inst. C.E., Roads and Bridges Branch, Public Works Department.
1876		Darley, Cecil West, M. Inst. C.E., Engineer-in-Chief, Public Works Department.
1877		Darley, The Hon. Sir Frederick, K.C.M.G., B.A., Chief Justice, Supreme Court.
1886		David, T. W. Edgeworth, B.A., F.G.S., Professor of Geology and Physical Geography, Sydney University, Glebe. *Vice-President.*
1878		Dean, Alexander, J.P., 42 Castlereagh-street, Box 409 G.P.O.
1885	P 1	Deane, Henry, M.A., M. Inst. C.E., Engineer-in-Chief for Railways, Railway Construction Branch, Public Works Department, p.r. 'Blanerne,' Wybalena Road, Hunter's Hill. *Vice-President.*
1877		Deck, John Feild, M.D. *Univ. St. And*, L.R.C.P. *Lond.*, M.R.C.S. *Eng.*, Ashfield.
1894		Dick, James Adam, B.A. *Syd.*, M.D., C.M. *Edin.*, 'Catfoss,' Belmore-road, Randwick.
1880		Dixson, Thomas, M.B. *Edin.*, Mast. Surg. *Edin.*, 287 Elizabeth-street, Hyde Park.
1875	P 12	Dixon, W. A., F.C.S., Fellow of the Institute of Chemistry of Great Britain and Ireland, 97 Pitt-street.
1879		Docker, Wilfred L., 'Nyrambla,' Darlinghurst Road.
1876		Docker, Ernest B., M.A. *Syd.*, District Court Judge, 'Carhullen,' Gradville.
1873	P 1	Du Faur, E., F.R.G.S., Exchange Buildings, Pitt-street.
1894		Edgell, Robert Gordon, Roads and Bridges Office, Wollombi.
1896		Edwards, George Rixon, Resident Engineer, Roads and Bridges Branch, Coonamble.
1874		Eichler, Charles F., M.D. *Heidelberg*, M.R.C.S. *Eng.*, 44 Bridge-st.
1896		Elwell, Paul B., M. Inst. C.E., M.I.E.E. &c., Australian Club.

Digitized by Google

Elected		
1879	P 4	Etheridge, Robert Junr., Curator, Australian Museum.
1876		Evans, George, Fitz Evan Chambers, Castlereagh-street.
1881		Evans, Thomas, M.R.C.S. *Eng.*, 211 Macquarie-street, North.
1892		Everett, W. Frank, Roads and Bridges Office, Muswellbrook.
1896		Fairfax, Charles Burton, *S. M. Herald* Office, Hunter-street.
1877		‡Fairfax, Edward Ross, *S. M. Herald* Office, Hunter-street.
1896		Fairfax, Geoffrey E., *S. M. Herald* Office, Hunter-street.
1868		Fairfax, Sir James R., Knt., *S. M. Herald* Office. Hunter-st.
1887		Faithfull, R. L., M.D. *New York* (Coll. Phys. & Surg.) L.R.C.P., L.S.A. *Lond.*, 18 Wylde-street.
1889		Farr, Joshua J., J.P., 'Cora Lynn,' Addison Rd., Marrickville.
1897		Fell, David, Public Accountant, Equitable Buildings, George-street.
1881		Fiaschi, Thos., M.D., M. Ch. *Univ. Pisa*, 149 Macquarie-street.
1891		Firth, Thomas Rhodes, M. Inst. C.E., Engineer-in-Chief, Existing Lines, p.r. 'Glenevin,' Arncliffe.
1891		Fitzgerald, Robert D., C.E., Roads and Bridges Branch, Department of Public Works, Sydney; p.r. Alexandra-st., Hunter's Hill.
1888		Fitzhardinge, Grantly Hyde, M.A. *Syd.*, District Court Judge, 'Nunda,' Birch Grove, Balmain.
1894		Fitz Nead, A. Churchill, E. S. & A. Bank, Ltd., Walker-street, North Sydney.
1879		‡Foreman, Joseph, M.R.C.S. *Eng.*, L.R.C.P. *Edin.*, 215 Macquarie-street.
1881		Foster, The Hon. W. J., Q.C., 'Thurnby,' Enmore Road, Newtown.
1881		Furber, T. F., Surveyor General's Office, 'Tennyson House,' 145 Victoria-street.
1889		Gale, Walter Frederick, F.R.A.S., Mem. A.S.P. & B.A.A., Savings' Bank of New South Wales, Newcastle.
1876		George, W. R., 318 George-street.
1879		Gerard, Francis, c/o Messrs. Du Faur & Gerard, Box 690 G.P.O.
1896		Gibson, Frederick William, District Court Judge, 'Grasmere,' Stanmore Road.
1891		Gill, Robert J., Public Works Department, Moruya.
1876	P 4	Gipps, F. B., C.E., 'Elmly,' Mordialloc, Victoria.
1883		Goode, W. H., M.A., M.D., Ch. M., Diplomate in State Medicine *Dub.*; Surgeon Royal Navy; Corres. Mem. Royal Dublin Society; Mem. Brit. Med. Assoc.; Lecturer on Medical Jurisprudence, University of Sydney, 159 Macquarie-st.
1859		Goodlet, John H., 'Canterbury House,' Ashfield.
1896		Gollin, Walter J., 'Winslow,' Darling Point.
1897		Gould, Albert John, J.P., Exchange, Bridge-street, p.r. 69 Roslyn Gardens.
1886		Graham, James, M.A., M.D., M.B., C.M. *Edin.*, M.L.A., 183 Liverpool-street.

Digitized by Google

Elected		
1891	P 1	Grimshaw, James Walter, M. Inst. C.E., M. I. Mech. E., &c., Australian Club, Sydney.
1898		Gurney, Elliott Henry, 'Glenavon,' Albert-st, Petersham.
1877		Gurney, T. T., M.A. *Cantab.*, Professor of Mathematics, Sydney University; p.r. 'Clavering,' French's Forest Road, Manly.
1891	P 1	Guthrie, Frederick B., F.C.S., Department of Agriculture, Sydney; p.r. 'Westella,' Wonga-street, Burwood.
1880		Halligan, Gerald H., C.E., 'Riversleigh,' Hunter's Hill.
1892		Halloran, Henry Ferdinand, L.S., Scott's Chambers, 94 Pitt-st.
1887	P 5	Hamlet, William M., F.C.S., F.I.C., Member of the Society of Public Analysts; Government Analyst, Health Department, Macquarie-street North. *Hon. Secretary.*
1882		Hankins, George Thomas, M.R.C.S. *Eng.*, 'St. Ronans,' Allison Road, Randwick.
1881		‡Harris, John, 'Bulwarra,' Jones-street. Ultimo.
1877	P 17	‡Hargrave, Lawrence, J.P., Stanwell Park, Clifton.
1884		Haswell, William Aitcheson, M.A., D. Sc., F.R.S., Professor of Zoolology and Comparative Anatomy, University, Sydney; p.r. St. Vigeans, Darling Point.
1896		Hay, Alexander, Coolangatta, N.S.W. and Australian Club.
1890	P 1	Haycroft, James Isaac, M.E. Queen's Univ. *Irel.*, Assoc. M. Inst. C.E., Assoc. M. Can. Soc. C.E., Assoc. M. Am. Soc. C.E., M.M. & C.E., M. Inst. C.E. I., L.S., 'Fontenoy,' Ocean-street, Woollahra.
1891	P 1	Hedley, Charles, F.L.S., Assistant in Zoology, Australian Museum, Sydney.
1884		Henson, Joshua B., C.E., Hunter District Water Supply and Sewerage Board, Newcastle.
1891		Hickson, Robert R. P., M. Inst. C.E., Under Secretary, Public Works Department, p.r. 'The Pines,' Bondi.
1876	P 2	Hirst, George D., 377 George-street.
1896		Hinder, Henry Critchley, M.B., C.M. *Syd.*, Elizabeth-st., Ashfield.
1891		Hood, Alexander Jarvie, M.B., Mast. Surg. *Glas.*, 219 Macquarie-street, City.
1892		Hodgson, Charles George, 157 Macquarie-street.
1891	P 2	Houghton, Thos. Harry, M. Inst. C.E., M.I. Mech. E., 12 Spring-street.
1879		Houison, Andrew, B.A., M.B., C.M. *Edin.*, 47 Phillip-street.
1891	P 1	How, William F., M. Inst. C.E., M. I. Mech. E., Wh. Sc., Mutual Life Buildings, George-street.
1877		Hume, J. K., 'Beulah,' Campbelltown.
1894	P 2	Hunt, Henry A., F. R. Met. Soc., Second Meteorological Assistant, Sydney Observatory.
1891		Hutchinson, William, M. Inst. C.E., Supervising Engineer, Railway Construction Branch, Public Works Department, Bogan Gate.
1891		Jamieson, Sydney, B.A., M.B., M.R.C.S., L.R.C.P., 157 Liverpool-street, Hyde Park.
1884		Jenkins, Edward Johnstone, M.A., M.D. *Oxon.*, M.R.C.P., M.R.C.S. L.S.A. *Lond.*, 213 Macquarie-street, North.

Digitized by Google

Elected		
1887		Jones, George Mander, M.R.C.S. *Eng.*, L.R.C.P. *Lond.*, 'Viwa,' Burlington Road, Homebush.
1879		Jones, John Trevor, C.E., 'Tremayne,' North Shore.
1884		Jones, Llewellyn Charles Russell, M.L.A., Solicitor, Sydney Chambers, 130 Pitt-street.
1867		Jones, P. Sydney, M.D. *Lond.*, F.R.C.S. *Eng.*, 16 College-street, Hyde Park, p.r. 'Llandilo,' Boulevard, Strathfield.
1876		Jones, Richard Theophilus, M.D. *Syd.*, L.R.C.P. *Edin.*, 'Caer Idris,' Ashfield.
1875	P 2	Josephson, J. Percy, Assoc. M. Inst. C.E., 'Moppity,' George-street, Dulwich Hill.
1878		Joubert, Numa, Hunter's Hill.
1883		Kater, The Hon. H. E., M.L.C., 'Cheverells,' Elizabeth Bay Rd.
1873		Keele, Thomas William, M. Inst. C.E., District Engineer, Harbours and Rivers Department, Ballina, Richmond River.
1877		Keep, John, Broughton Hall, Leichhardt.
1894		Kelly, Walter MacDonnell, L.R.C.P., L.R.C.S. *Edin.*, L.F.P.S. *Glas.*, 265 Elizabeth-street.
1887		Kent, Harry C., Bell's Chambers, 129 Pitt-street.
1898		Kerry, Charles H., 310 George-street.
1892	P 2	Kiddle, Hugh Charles, F. R. Met. Soc., Public School, Seven Oaks, Smithtown, Macleay River.
1891		King, Christopher Watkins, Assoc. M. Inst. C.E., L.S., Roads and Bridges Branch, Public Works Department, Sydney.
1874		King, The Hon. Philip G., M.L.C., 'Banksia,' William-street, Double Bay.
1896		King, Kelso, 'Glenhurst,' Darling Point.
1892		Kirkcaldie, David, Commissioner, New South Wales Government Railways, Sydney.
1878		Knaggs, Samuel T., M.D. *Aberdeen*, F.R.C.S. *Irel.*, 5 Lyons' Terrace, Hyde Park.
1881	P 7	Knibbs, G. H., F.R.A.S., Lecturer in Surveying, University of Sydney; p.r. 'Avoca House,' Denison Road, Petersham. *President.*
1877		Knox, Edward W., J.P., 'Rona,' Bellevue Hill, Rose Bay.
1875		Knox, The Hon. Sir Edward, Knt., M.L.C., 'Fiona,' New South Head Road, Woollahra.
1878		Kyngdon, F. B., F.R.M.S. *Lond.*, Deanery Cottage, Bowral.
1874		Lenehan, Henry Alfred, F.R.A.S., Sydney Observatory.
1883		Lingen, J. T., M.A. *Cantab.*, 167 Phillip-street.
1872	P 48	Liversidge, Archibald, M.A. *Cantab.*, LL.D., F.R.S.; Assoc. Roy. Sch. Mines, *Lond.*; F.C.S., F.G.S., F.R.G.S.; Fel. Inst. Chem. of Gt. Brit. and Irel.; Hon. Fel. Roy. Historical Soc. *Lond.*; Mem. Phy. Soc., *Lond*; Mineralogical Society, *Lond.*; Edin. Geol. Soc.; Mineralogical Society, *France;* Cor. Mem. Edin. Geol. Soc.; Roy. Soc., *Tas.*; Roy. Soc., *Queensland;* Senckenberg Institute, *Frankfurt*; Society d'Acclimat., *Mauritius*; Hon. Mem. Roy. Soc., *Vict.*; N. Z. Institute; K. Leop. Carol. Acad., *Halle a/s*; Professor of Chemistry in the University of Sydney, The University, Glebe; p.r. 'The Octagon,' St. Mark's Road, Darling Point.

Digitized by Google

Elected		
1881		Lloyd, Lancelot T., 'Eurotah,' William-street, East.
1878		Low, Hamilton, 32 Cavendish-street, Petersham.
1897		Low, John S., Business Manager, The United Australian Exploration, Ltd., Equitable Buildings, George-street, Box 474 G.P.O., Sydney.
1887		MacAllister, John F., M.B., B.S. *Melb.*, 'Ewhurst,' Stanmore Road, Stanmore.
1892		MacCarthy, Charles W., M.D., F.R.C.S. *Irel.*, 223 Elizabeth-street, Hyde Park.
1884		MacCormick, Alexander, M.D., C.M. *Edin.*, M.R.C.S. *Eng.*, 125 Macquarie-street, North.
1887		MacCulloch, Stanhope H., M.B., C.M. *Edin.*, 24 College-street.
1874		M'Cutcheon, John Warner, Assayer to the Sydney Branch of the Royal Mint.
1892		McDonagh, John M., B.A., M.D., M.R.C.P. *Lond.*, F.R.C.S. *Irel.*, 173 Macquarie-street, North.
1897		MacDonald, C. A., C.E., 63 Pitt-street.
1878		MacDonald, Ebenezer, J.P., 'Kamilaroi,' Darling Point.
1868		MacDonnell, William J., F.R.A.S., c/o Mr. W. C. Goddard, Norwich Chambers, Hunter-street.
1877		MacDonnell, Samuel, 12 Pitt-street.
1891		McDouall, Herbert Crichton, M.R.C.S. *Eng.*, L.R.C.P. *Lond.*, Hospital for Insane, Newcastle.
1893		McKay, William J. Stewart, B. Sc., M.B., Ch. M., Cambridge-street, Stanmore.
1876		Mackellar, The Hon. Charles Kinnaird, M.L.C., M B., C.M. *Glas.*, 183 Liverpool-street, Hyde Park; p.r. 'Dunara,' Rose Bay.
1872		Mackenzie, John, F.G S., Athenæum Club, Sydney.
1876		Mackenzie, Rev. P. F., The Manse, Johnston-st., Annandale.
1880	P 5	M'Kinney, Hugh Giffin, M.E. Roy. Univ. *Irel.*, M. Inst. C.E., Chief Engineer for Water Conservation, Athenæum Club, Castlereagh-street.
1876		MacLaurin, The Hon. Henry Norman, M.L.C., M.A., M.D. *Edin.*, L.R.C.S. *Edin.*, LL.D. Univ. *St. Andrews*, 155 Macquarie-st.
1894		McMillan, William, 'St. Kilda,' Allison-st., Randwick.
1882		Madsen, Hans. F., 'Hesselmed House,' Queen-st., Newtown.
1883	P 6	Maiden, J. Henry, F.L.S., Corr. Memb. Pharm. Soc. Gt. Brit.; Hon. Memb. Royal Netherlands Soc. (Haarlem); of the Philadelphia Coll. of Pharmacy; of the Royal Soc. of S.A.; of the Mueller Botanic Soc. of W.A.; Director, Botanic Gardens, Sydney. *Hon. Secretary.*
1878		Maitland. Duncan Mearns, District Surveyor, Armidale.
1880	P 1	Manfred, Edmund C., Montague-street, Goulburn.
1877		Mann, John F., 'Kerepunu,' Neutral Bay.
1879		Manning, Frederic Norton, E.D. Univ. *St. And.*, M.R.C.S. *Eng.*, L.S.A. *Lond.*, Hunter's Hill.
1869		Mansfield, G. Allen, Martin Chambers, Moore-street.
1897		Marden, John, B.A., M.A., LL.B Univ. *Melb.*, LL.D. Univ. *Syd.*, Principal, Presbyterian Ladies' College, Sydney.
1875	P 7	Mathews, Robert Hamilton, L.S., Cor. Mem. Anthrop. Inst. Gt. Brit. and Irel.; Cor. Mem. Anthrop. Soc., Washington, U.S.A.; Cor. Mem. Roy. Geogr. Soc. Aust., Queensland, 'Carcuron,' Hassall-street, Parramatta.

Digitized by Google

Elected		
1888		Megginson, A. M., M.B., C.M. *Edin.*, 243 Elizabeth-street.
1896	P 3	Merfield, Charles J., F.R.A.S., Railway Construction Branch, Public Works Department, p.r. 'Branville,' Green Bank-street, Marrickville.
1887		Miles, George E., L.R.C.P. *Lond.*, M.R.C.S. *Eng.*, The Hospital, Rydalmere, Near Parramatta.
1873		Milford, F., M.D., *Heidelberg*, M.R.C.S. *Eng.*, 231 Elizabeth-st.
1882		Milson, James, 'Elamang,' North Shore.
1889	P 3	Mingaye, John C. H., F.C.S., M.A.I.M.E., Assayer and Analyst to the Department of Mines, Sydney.
1892		Mollison, James Smith, M. Inst. C.E., Roads, Bridges and Sewerage Branch, Department of Public Works, Sydney.
1856	P 7	Moore, Charles, F.L.S., Australian Club, p.r. 4 Queen-street, Woollahra.
1879		Moore, Frederick H., Illawarra Coal Co., Gresham-street.
1875		Moir, James, 58 Margaret-street.
1877	P 1	Morris, William, Fel. Fac. Phys. and Surg. *Glas.*, F.R.M.S. *Lond.*, 5 Bligh-street.
1882		Moss, Sydney, 'Kaloola,' Kiribilli Point, North Shore.
1877		‡Mullens, Josiah, F.R.G.S., 'Tenilba,' Burwood.
1879		Mullins, John Francis Lane, M.A. *Syd.*, 'Killountan,' Challis Avenue, Pott's Point.
1888		Mullins, George Lane, M.A., M.D. Trin. Coll. *Dub.*, M.D. *Syd.*, F.R.M.S. *Lond.*, No. 293 Elizabeth-street.
1887		Munro, William John, M.B., C.M. *Edin.*, M.R.C.S. *Eng.*, c/o Miss Munro, 'Chester,' Stanmore.
1898		Murray, Lee, M.C.E. *Melb.*, 65 Pitt-street.
1876		Myles, Charles Henry, 'Dingadee,' Burwood.
1893		Nangle, James, Architect, Australia-street, Newtown.
1890		Neill, Leopold Edward Flood, M.B., Ch. M. Univ. *Syd.*, No. 3, Bayswater Houses, Double Bay.
1891		Noble, Ewald George, 60 Louisa Road, Longnose Point, Balmain.
1873		Norton, The Hon. James, M.L.C., LL.D., Solicitor, 2 O'Connell-street, p.r. 'Ecclesbourne,' Double Bay.
1893		Noyes, Edward, C.E., 'Waima,' Wentworth Road, Point Piper, Sydney.
1878		Ogilvy, James L., Melbourne Club, Melbourne.
1888		O'Neill, G. Lamb, M.B., C.M. *Edin.*, 291 Elizabeth-street.
1896		Onslow, Lt. Col. James William Macarthur, Camden Park, Menangle.
1875		O'Reilly, W. W. J., M.D., M. Ch. Q. Univ. *Irel.*, M.R.C.S. *Eng.*, 197 Liverpool-street.
1883		Osborne, Ben. M., J.P., 'Hopewood,' Bowral.
1891		Osborn, A. F., Assoc. M. Inst. C.E., Public Works Department, Cowra.
1893		Owen, Captain Percy Thomas, Victoria Barracks, and Australian Club.

Digitized by Google

Elected		
1883		Palmer, Joseph, 133 Pitt-st, p.r. Kenneth-st., Willoughby.
1878		Paterson, Hugh, 197 Liverpool-street, Hyde Park.
1877		Pedley, Perceval R., 227 Macquarie-street.
1877		Perkins, Henry A., 'Barangah,' Coventry Road, Homebush.
1876		Pickburn, Thomas, M.D., C.M. *Aberdeen*, M.R.C.S. *Eng.*, 22 College-street.
1879	P 4	Pittman, Edward F., Assoc. R.S.M., L.S., Government Geologist, Department of Mines.
1881		Poate, Frederick, District Surveyor, Tamworth.
1890		Pockley, Francis Antill, M.B., M. Ch. Univ. *Edin.*, M.R.C.S. *Eng.*, 227 Macquarie-street.
1879		Pockley, Thomas F. G., Commercial Bank, Singleton.
1887		Pollock, James Arthur, B.E. Roy. Univ. *Irel.*, B. Sc. *Syd.*, Demonstrator in Physics, Sydney University.
1891		Poole, William Junr., Assoc. M. Inst. C.E., 87 Pitt-street, Redfern.
1896		Pope, Roland James, M.D., C.M., F.R.C.S. *Edin.*, Ophthalmic Surgeon, 235 Macquarie-street.
1882	P 5	Porter, Donald A., Tamworth.
1897	P 1	Portus, A. B., Assoc. M. Inst. C.E., Superintendent of Dredges, Public Works Department.
1893		Purser, Cecil, B.A., M.B., Ch. M. *Syd.*, 'Valdemar,' Boulevard, Petersham.
1876		Quaife, Frederick H., M.A., M.D., Master of Surgery *Glas.*, 'Hughenden,' 19 Queen-street, Woollahra.
1865	P 1	‡Ramsay, Edward P., LL.D. Univ. St. And., F.R.S.E., F.L.S., Petersham.
1868		Reading, E., Mem. Odont. Soc. *Lond.*, Elizabeth-street, Hyde Park, p.r. Fullerton-street, Woollahra.
1888		Reading, Richard Fairfax, M.R.C.S. *Eng.*, L.R.C.P. *Lond.*, L.D.S. *Eng.*, 151 Macquarie-street.
1881	P 3	Rennie, Edward H., M.A. *Syd.*, D. Sc. *Lond.*, Professor of Chemistry, University, Adelaide.
1870		Renwick, The Hon. Sir Arthur, M.L.C., B.A. *Syd.*, M.D., F.R.C.S. *Edin.*, 295 Elizabeth-street.
1893	P 1	Roberts, W. S. de Lisle, C.E., Sewerage Branch, Public Works Department, Phillip-street.
1885		Rolleston, John C., C.E., Harbours and Rivers Branch, Public Works Department.
1897		Ronaldson, James Henry, Mining Engineer, 32 Macleay-st., Pott's Point.
1892		Rossbach, William, Assoc. M. Inst. C.E., Chief Draftsman, Harbours and Rivers Branch, Public Works Department.
1884		Ross, Chisholm, M.D. *Syd.*, M.B., C.M. *Edin.*, Hospital for the Insane, Kenmore, Near Goulburn.
1895		Ross, Colin John, B.Sc., B.E., Assoc. M. Inst. C.E., Borough Engineer, Town Hall, North Sydney.
1895	P 1	Ross, Herbert E., Consulting Mining Engineer, Equitable Buildings, George-street.
1882		Rothe, W. H., Colonial Sugar Co., O'Connell-st., and Union Club.

Digitized by Google

Elected		
1894		Rowney, George Henry, Assoc. M. Inst. C.E., Water and Sewerage Board, Pitt-street; p.r. 'Maryville,' Ben Boyd Road, Neutral Bay.
1864	P 63	Russell, Henry C., B.A. *Syd.*, C.M.G., F.R.S., F.R.A.S., F.R. Met. Soc. Hon. Memb. Roy. Soc., South Australia, Government Astronomer, Sydney Observatory.
1897		Russell, Harry Ambrose, B.A., Solicitor, c/o Messrs. Sly and Russell, 379*b* George-street; p.r. 'Mahuru,' Milton-street, Ashfield.
1883		Rygate, Philip W., M.A., B.E. *Syd.*, 98 Pitt-street.
1892	P 1	Schofield, James Alexander, F.C.S., A.R.S.M., University, Sydney
1856	P 1	‡Scott, Rev. William, M.A. *Cantab.*, Kurrajong Heights.
1886		Scott, Walter, M.A. *Oxon.*, Professor of Greek, University, Sydney.
1877	P 2	Selfe, Norman, M. Inst. C.E., M. I. Mech. E., Victoria Chambers, 279 George-street.
1890	P 1	Sellors, R. P., B.A. *Syd.*, F.R.A.S., Sydney Observatory.
1891		Shaw, Percy William, Assoc. M. Inst. C.E., Resident Engineer for Tramway Construction; p.r. 'Leswell,' Torrington Road, Strathfield.
1883	P 3	Shellshear, Walter, M. Inst. C.E., Divisional Engineer, Railway Department, Goulburn.
1879		Shepard, A. D., Box 728 G.P.O. Sydney.
1882		Shewen, Alfred, M.D. Univ. *Lond.*, M.R.C.S. *Eng.*, 6 Lyons' Terrace, Hyde Park.
1894		Simpson, Benjamin Crispin, M. Inst. C.E., 113 Phillip-street.
1882		Sinclair, Eric, M.D., C.M. Univ. *Glas.*, Hospital for the Insane, Gladesville.
1893		Sinclair, Russell, M.I. Mech.E. &c., Consulting Engineer, 97 Pitt-st.
1884		Skirving, Robert Scot, M.B., C.M. *Edin.*, Elizabeth-street, Hyde Park.
1891	P 1	Smail, J. M., M. Inst. C.E., Chief Engineer, Metropolitan Board of Water Supply and Sewerage, 341 Pitt-street.
1893	P 16	Smith, Henry G., F.C.S., Technological Museum, Sydney.
1874	P 1	‡Smith, John McGarvie, Denison-street, Woollahra.
1875		Smith, Robert, M.A. *Syd.*, Marlborough Chambers, 2 O'Connell-street.
1898		Smith, S. Hague, Manager N. Z. Fire and Marine Insurance Co., 81 Pitt-street.
1886		Smith, Walter Alexander, M. Inst. C.E., Roads, Bridges and Sewerage Branch, Public Works Department, N. Sydney.
1896		Smyth, Selwood, Harbours and Rivers Branch, Public Works Department.
1896		Spencer, Walter, M.D. *Brux.*, 13 Edgeware Road, Enmore.
1892	P 1	Statham, Edwyn Joseph, Assoc. M. Inst. C.E., 'Fenella,' Frederick-street, Rockdale.
1882		Steel, John, L.R.C.P., L.R.C.S. *Edin.*, Ch. M. B.S. Univ. *Melb.*, 3 Lyons' Terrace, Hyde Park.
1889		Stephen, Arthur Winbourn, L.S., 86 Pitt-street.
1879		‡Stephen, The Hon. Septimus A., M.L.C., 12—14 O'Connell-st.
1891		Stilwell, A. W., Assoc. M. Inst. C.E., 'Oakstead,' Russell-st., Bathurst

Digitized by Google

Elected		
1883	P 3	Stuart, T. P. Anderson, M.D. Univ. *Edin.*, Professor of Physiology, University of Sydney; p.r. 'Lincluden,' Fairfax Road, Double Bay. *Vice-President.*
1892		Sturt, Clifton, L.R.C.P. L.R.C.S. *Edin.*, L.F.P.S. *Glas.*, 'Wistaria,' Bulli.
1876	P 1	Suttor, The Hon. W. H., M.L.C., 3 Albert-street, Woollahra.
1893		‡Taylor, James, B. Sc., A. R. S. M., Government Metallurgist, Adderton Road, Dundas.
1861	P 19	Tebbutt, John, F.R.A.S., Private Observatory, The Peninsula, Windsor, New South Wales.
1896		Thom, James Campbell, Solicitor for Railways, p.r. 'Camelot,' Forest Road, Bexley.
1896		Thom, John Stuart, Solicitor, Athenæum Chambers, 11 Castlereagh-street; p.r. Wollongong Road, Arncliffe.
1878		Thomas, F. J., Hunter River N.S.N. Co., Sussex:street.
1879		Thomson, Dugald, M.L.A., 'Wyreepi,' Milson's Point.
1875		Thompson, Joseph, 159 Brougham-street, Woolloomooloo.
1885	P 2	Thompson, John Ashburton, M.D. *Brux.*, D.P.H. *Camb.*, M.R.C.S. *Eng.*, Health Department, Macquarie-street.
1896		Thompson, Capt. A. J. Onslow, Camden Park, Menangle.
1898		Thow, Sydney, 24 Bond-street.
1892		Thow, William, M. Inst. C.E., M. I. Mech. E., Locomotive Department, Eveleigh.
1886	P 5	Threlfall, Richard, M.A. *Cantab.*, Professor of Physics, University of Sydney. *Vice-President.*
1888		Thring, Edward T., F.R.C.S. *Eng.*, L.R.C.P. *Lond.*, 225 Macquarie-street.
1876		Tibbits, Walter Hugh, M.R.C.S. *Eng.*, Gunning.
1896		Tickle, Arthur H., 'Adderton,' Fullerton-street, Woollahra.
1894		Tidswell, Frank, M.B., M. Ch., D.P.H., 'Nugal Lodge,' Milford-st., Randwick.
1876		Toohey, The Hon. J. T., M.L.C., 'Moira,' Burwood.
1894		Tooth, Arthur W., Australian Club, Bent-street.
1873	P 1	Trebeck, Prosper N., J.P., 2 O'Connell-street.
1879		Trebeck, P. C., 2 O'Connell-street.
1877		‡Tucker, G. A., Ph. D., c/o Perpetual Trustee Co., 2 Spring-st.
1883		Vause, Arthur John, M.B., C.M. *Edin.*, 'Bay View House,' Tempe.
1884		Verde, Capitaine Felice, Ing. Cav., viâ Fazio 2, Spezia, Italy.
1896		Verdon, Arthur, Australian Club.
1890		Vicars, James, M.C.E., Assoc. M. Inst. C.E., City Surveyor, Adelaide.
1892		Vickery, George B., 78 Pitt-street.
1896		Vivian, Walter Hussey, Stock and Share Broker, 100 Pitt-st., p.r. 'The Châlet, Manly.
1876		Voss, Houlton H., J.P., c/o Perpetual Trustee Company, 2 Spring-street.

Digitized by Google

Elected		
1898		Wade, Leslie A. B., C.E., Department of Public Works.
1879		Walker, H. O., Commercial Union Assurance Co., Pitt-street.
1891		Walsh, Henry Deane, B.E., T.C. *Dub.*, M. Inst. C.E., Supervising Engineer, Harbours and Bivers Department, Newcastle.
1896		Walsh, C. R., Prothonotary, Supreme Court.
1895		Ward, Thomas Wenman, 271 Bourke-street.
1891		Ward, Thomas William Chapman, B.A., B.C.E. *Syd.*, 'Birkdale,' 26 Mansfield-street, Glebe Point.
1898		Wark, William, 9 Macquarie Place; p.r. Kurrajong Heights.
1877		Warren, William Edward, B.A., M.D., M. Ch., Queen's University *Irel.*. M.D. *Syd.*, 263 Elizabeth-street, Sydney.
1883	P 9	Warren, W. H., Wh Sc., M. Inst. C.E., Professor of Engineering, University of Sydney.
1876		Watkins, John Leo, B.A. *Cantab.*, M.A. *Syd.*, Parliamentary Draftsman, Attorney General's Department, 5 Richmond Terrace, Domain.
1876		Watson, C. Russell, M.R.C.S. *Eng.*, 'Woodbine,' Erskineville Road, Newtown.
1859		Watt, Charles, Parramatta.
1897		Webb, Fredk. William, C.M.G., J.P., Clerk of the Legislative Assembly; p.r. 'Livadia,' Chandos-street, Ashfield.
1866		Webster, A. S., c/o Permanent Trustee Co., 16 O'Connell-st.
1892		Webster, James Philip, Assoc. M. Inst. C.E., L.S., *New Zealand*, Borough Engineer, Town Hall, Marrickville.
1867		Weigall, Albert Bythesea, B.A. *Oxon.*, M.A. *Syd.*, Head Master, Sydney Grammar School, College-street.
1881		‡Wesley, W. H.
1878		Westgarth, G. C., Bond-street; p.r. 52 Elizabeth Bay Road.
1879		‡Whitfeld, Lewis, M.A. *Syd.*, 'Oaklands,' Edgecliffe Road.
1892		White, Harold Pogson, Assistant Assayer and Analyst, Dept. of Mines; p.r. 'Chester,' Station-street, Auburn.
1877		‡White, Rev. W. Moore, A.M., LL.D., T.C.D.
1874		White, Rev. James S., M.A., LL.D. *Syd.*, 'Gowrie,' Singleton.
1888		White, The Hon. Robert Hoddle Driberg, M.L.C., Union Club; p.r. 'Tahlee,' Port Stephens.
1898		Wildridge, John, M.I. Mech. E., &c., 97 Pitt-street.
1878		Wilkinson, Rev. Samuel, 'Regent House,' Regent-street, Petersham.
1883		Wilkinson, W. Camac, M.D. *Lond.*, M.R.C.P. *Lond.*, M.R.C.S. *Eng.*, 207 Macquarie-street.
1876		Williams, Percy Edward, Department of Audit; p.r. 'Everley,' Drummoyne-street, Hunter's Hill.
1878		Wilshire, James Thompson, F.L.S., F.R.H.S., J.P., 'Coolooli,' off Ranger's Road, Shell Cove, Neutral Bay.
1879		Wilshire, F. R., P.M., Penrith.
1891		Wilson, Robert Archibald, M.D. *Glas.*, Mast. Surg. *Glas.*, 2 Booth-street, Balmain.
1890		Wilson, James T., M.B., Mast. Surg. Univ. *Edin.*, Professor of Anatomy, University of Sydney.
1873		Wood, Harrie, J.P., 10 Bligh-st.; p.r. 54 Darlinghurst Road.
1891		Wood, Percy Moore, L.R.C.P. *Lond.*, M.R.C.S. *Eng.*, 'Redcliffe,' Liverpool Road, Ashfield.
1876	P 1	Woolrych, F. B. W., 'Verner,' Grosvenor-street, Croydon.
1872		Wright, Horatio G. A, M.R.C.S. *Eng.*, L.S.A. *Lond.*, 4 York-st., Wynyard Square. *Hon. Treasurer.*
1893		Wright, John, C.E., Toxteth-street, Glebe Point.

Digitized by Google

Elected		
1879		Young, John, 'Kentville,' Johnston-street, Leichhardt.

Honorary Members.

Limited to Twenty.

M.—Recipients of the Clarke Medal.

1878		Agnew, Sir James, K.C.M.G., M.D., Hon. Secretary, Royal Society of Tasmania, Hobart.
1875		Bernays, Lewis A., C.M.G., F.L.S., Brisbane.
1895		Bunsen, Professor Robert Wilhelm, For. Mem. R.S., Heidelberg.
1875	M	Ellery, Robert L. J., F.R.S., F.R.A.S., late Government Astronomer of Victoria, Melbourne.
1887		Foster, Michael, M.D., F.R.S., Professor of Physiology, University of Cambridge.
1875	M	Gregory, The Hon. Augustus Charles, C.M.G., M.L.C., F.R.G.S., Brisbane.
1875	P 1 M	Hector, Sir James, K.C.M.G., M.D., F.R.S., Director of the Colonial Museum and Geological Survey of New Zealand, Wellington, N.Z.
1880	M	Hooker, Sir Joseph Dalton, K.C.S.I., M.D., C.B., F.R.S., &c., late Director of the Royal Gardens, Kew.
1892		Huggins, Sir William, K.C.B., D.C.L., LL.D., F.R.S., &c., 90 Upper Tulse Hill, London, S.W.
1888	P 1 M	Hutton, Captain Frederick Wollaston, F.G.S., Curator, Canterbury Museum, Christchurch, New Zealand.
1875	M	M'Coy, Frederick, C.M.G., D.Sc., F.R.S., F.G.S., Hon. M.C.P.S., C.M.Z.S., Professor of Natural Science in the Melbourne University, Government Palæontologist, and Director of National Museum, Melbourne.
1894		Spencer, W. Baldwin, M.A., Professor of Biology, University of Melbourne.
1888	P 3 M	Tate, Ralph, F.G.S., F.L.S., Professor of Natural Science, University, Adelaide, South Australia.
1895		Wallace, Alfred Russel, D.C.L. *Oxon.*, LL.D. *Dublin*, F.R.S. Parkstone, Dorset.

Corresponding Members.

Limited to Twenty-five.

1886		Marcou, Professor Jules, F.G.S., Cambridge, Mass., United States of America.

Obituary.

1898.

Honorary Member

1875		Waterhouse, F. G.

Ordinary Members.

1877		Bundock, W. C.
1875		De Salis, L. F.
1877		Kopsch, G. A.
1887		Long, A. Parry
1868		Roberts, Sir Alfred

Digitized by Google

AWARDS OF THE CLARKE MEDAL.

Established in memory of

THE LATE REVD. W. B. CLARKE, M.A., F.R.S., F.G.S., &c.,

Vice-President from 1866 *to* 1878.

To be awarded from time to time for meritorious contributions to the Geology, Mineralogy, or Natural History of Australia.

1878 Professor Sir Richard Owen. K.C.B., F.R.S., Hampton Court.
1879 George Bentham, C.M.G., F.R.S., The Royal Gardens, Kew.
1880 Professor Huxley, F.R.S., The Royal School of Mines, London, 4 Marlborough Place, Abbey Road, N.W.
1881 Professor F. M'Coy, F.R.S., F.G.S., The University of Melbourne.
1882 Professor James Dwight Dana, LL.D., Yale College, New Haven, Conn., United States of America.
1883 Baron Ferdinand von Mueller, K.C.M.G, M.D., PH.D., F.R.S., F.L.S., Government Botanist, Melbourne.
1884 Alfred R. C. Selwyn, LL.D., F.R.S., F.G.S., late Director of the Geological Survey of Canada, Ottawa.
1885 Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., &c., late Director of the Royal Gardens, Kew.
1886 Professor L. G. De Koninck, M.D., University of Liège, Belgium.
1887 Sir James Hector, K.C.M.G., M.D., F.R.S., Director of the Geological Survey of New Zealand, Wellington, N.Z.
1888 Rev. Julian E. Tenison-Woods, F.G.S., F.L.S., Sydney.
1889 Robert Lewis John Ellery, F.R.S., F.R.A.S., late Government Astronomer of Victoria, Melbourne.
1890 George Bennett, M.D. Univ. *Glas.*, F.R.C.S. *Eng.*, F.L.S., F.Z.S., William Street, Sydney.
1891 Captain Frederick Wollaston Hutton, F.R.S., F.G.S., Curator, Canterbury Museum, Christchurch, New Zealand.
1892 Sir William Turner Thiselton Dyer, K.C.M.G., C.I.E., M.A., B.Sc., F.R.S., F.L.S., Director, Royal Gardens, Kew.
1893 Professor Ralph Tate, F.L.S., F.G.S., University, Adelaide, S.A.
1895 Robert Logan Jack, F.G.S., F.R.G.S., Government Geologist, Brisbane, Queensland.
1895 Robert Etheridge, Junr., Government Palæontologist, Curator of the Australian Museum, Sydney.
1896 Hon. Augustus Charles Gregory, C.M.G., M.L.C., F.R.G.S., Brisbane.

AWARDS OF THE SOCIETY'S MEDAL AND MONEY PRIZE.

The Royal Society of New South Wales offers its Medal and Money Prize for the best communication (provided it be of sufficient merit) containing the results of original research or observation upon various subjects published annually.

Money Prize of £25.

1882 John Fraser, B.A., West Maitland, for paper on 'The Aborigines of New South Wales.'
1882 Andrew Ross, M.D., Molong, for paper on the 'Influence of the Australian climate and pastures upon the growth of wool.'

Digitized by Google

The Society's Bronze Medal and £25.

1884 W. E. Abbott, Wingen, for paper on 'Water supply in the Interior of New South Wales.'

1886 S. H. Cox, F.G.S., F.C.S., Sydney, for paper on 'The Tin deposits of New South Wales.

1887 Jonathan Seaver, F.G.S., Sydney, for paper on 'Origin and mode of occurrence of gold-bearing veins and of the associated Minerals.

1888 Rev. J. E. Tenison-Woods, F.G.S., F.L.S., Sydney, for paper on 'The Anatomy and Life-history of Mollusca peculiar to Australia.'

1889 Thomas Whitelegge, F.R.M.S., Sydney, for 'List of the Marine and Fresh-water Invertebrate Fauna of Port Jackson and Neighbourhood.

1889 Rev. John Mathew, M.A., Coburg, Victoria, for paper on 'The Australian Aborigines.

1891 Rev. J. Milne Curran, F.G.S., Sydney, for paper on 'The Microscopic Structure of Australian Rocks.'

1892 Alexander G. Hamilton, Public School, Mount Kembla, for paper on 'The effect which settlement in Australia has produced upon Indigenous Vegetation.'

1894 J. V. De Coque, for paper on the 'Timbers of New South Wales.

1894 R. H. Mathews, L.S., for paper on 'The Aboriginal Rock Carvings and Paintings in New South Wales.

1895 C. J. Martin, B.Sc., M.B. *Lond.*, for paper on 'The physiological action of the venom of the Australian black snake (*Pseudechis porphyriacus*).

1896 Rev. J. Milne Curran, Sydney, for paper on "The occurrence of Precious Stones in New South Wales, with a description of the Deposits in which they are found."

Digitized by Google

Digitized by Google

ANNIVERSARY ADDRESS.

By HENRY DEANE, M.A., M. Inst. C.E.

[*Delivered to the Royal Society of N. S. Wales, May 4, 1898.*]

INTRODUCTION.—A Presidential Address to a Society like ours falls naturally into three divisions. The first division consists of a report on the Society's affairs and doings during the past twelve months. The second embodies a statement of important matters and work relating to Science done outside the Society and especially in this Colony. After this the President, I find, generally delivers a thesis or review of some matter which is a topic of special interest to himself and the Society, and which circumstances or recent investigations render fitting for inclusion in the address.

The second division is one which may be indefinitely extended. It is impossible to make it very short, but it may be left out altogether. I have endeavoured to adopt a middle course, and excluded as much as possible routine work from my account, and I have selected those matters only which show novelty or which on account of their importance call for special reference.

With regard to the third division, I was for some time very much in doubt, whether, on the hitherto rare occasion of a Civil Engineer holding this office, it was not incumbent on me to take up some subject pertinent to my profession, but I thought that that duty could be well left to the chairman of the Engineering Section, who might be looked upon as the official representative in this Society of the engineering profession. It seems to me that the occasion of the meeting of the Australasian Association for the Advancement of Science in this city, gives an opportunity for discussing the merits of science and scientific training which ought not to be passed over, and I have therefore, devoted myself to those subjects, but at the same time I must ask the members not to overlook the difficulties under which I labour, and not to

Digitized by Google

criticise too severely the form of the matter presented to them, when its subject has been dealt with previously, though perhaps from other standpoints, by some of the most able scientific writers in the English language.

Part I.—HISTORY OF THE SOCIETY DURING THE PAST YEAR:—

During the past year the roll of members has undergone considerable diminution. On the 30th April, 1897, it was four hundred and fourteen, the number of new members elected is twelve, while the loss by death (five), resignation or otherwise (twenty-four), has amounted to twenty-nine, leaving a net loss of seventeen. When it is considered that this means not only a diminished income from subscriptions of £27 6s., but that the Government subsidy becomes reduced by exactly the same amount it will be seen to be no trifling matter as affecting our financial position. In addition to this the past year has been one of exceptionally heavy expense; not only has the Society had to bear the first strain on its finances, due to the interest on the cost of alterations to our building, the debt on which amounts to £1800, but it was found desirable that on the occasion of the meeting in this city of the Australasian Association for the Advancement of Science, a conversazione should be held, involving of course a heavy expenditure. Had it not been for the advent of the Association the Council would probably have postponed the holding of this important reunion till the following year. It is evident that during the ensuing year the strictest economy will have to be observed. Illustration is a serious item in the cost of publishing the Society's journal, and in order to secure at the same time both efficiency and economy, it is necessary that authors should consult the editors before preparing their illustrations. This requirement of our existing editorial regulations must in view of the pressing necessity for economy be stringently enforced in future.

It must be a matter of surprise that a Society of this kind is not more largely supported than is the case. It should be looked upon as an honour and a privilege to be able to co-operate in the

Digitized by Google

vanguard of science, and thus help in the progress of civilization, which without science would be nothing. There are many residents in our community whose position and intelligence would make them desirable members, and I cannot help thinking that if the reasons for the existence of our Society and the good that they might do in aiding progress were clearly before them, they would not hesitate to join us. It would be well if members would look round and endeavour to bring in those of their friends who would be a help to us.

It has often been put forward as a reason for not joining a Society like ours, or by those already members, given as an excuse for resigning, that the individual was not able to attend the meetings and consequently drew no benefit from membership. Every one who pays his subscription receives the annual volume in due course, but as this is issued only some time after the completion of the year and perhaps twelve months or nearly so after the first papers have been read, it is a long time to wait for a printed account of what is done at the meetings, and by the time it arrives interest has possibly somewhat slackened in the particular subjects treated.

We cannot of course expect everybody to act upon purely disinterested motives and pay his subscription to the Society in order that the Colony may advance in scientific thought, while he himself gets nothing directly out of it, so that one may consider the question from the selfish point of view, and admit for the moment that the objection mentioned above is valid.

"*Abstract.*"—To meet this objection the Council has thought fit to issue an "Abstract" of Proceedings or report of the work done at each monthly meeting, as soon after as it is possible to compile and get the matter printed, and a copy of this is sent round to every member, so that he may know what has been going on even if he cannot attend the particular meeting. During the past year a concise account of the proceedings at the monthly meetings has been prepared and forwarded. For the excellence of the work done we are indebted to the energy and ability of our

Digitized by Google

Honorary Secretary, Mr. Knibbs. The work so far has cost between £14 and £15, a small amount when we consider the result gained, which I think nearly every member will agree is a good one. It keeps members at a distance in touch with the work of the Society, and it gives an opportunity to those who have intended to be present at a meeting and who have been hindered from attending of informing themselves as to how the subjects of the papers were treated.

It is gratifying to note the large number of engineers on the roll of the Society. The Engineering Section is a very active one, and it has proved the rallying ground of the members of the engineering and surveying professions. The formation of such a section is a very wise and economical way of carrying forward the interest of their particular calling, for not only do they gain the advantage to be derived from membership in a larger and wealthier society, but the Society generally is strengthened by such addition and co-operation, both in a literary and financial manner. Among other things to the advantage of such members is the use of a valuable library and reading room.

One would like to see other bodies of men bound together by a common interest, who have not already formed themselves into distinct societies, join our Society and use the opportunities afforded. I would suggest, among others the formation of a Literary Section. Reference to the objects of the Society as stated in the Act of Incorporation, will show that Literature is one of them, Art is another. Formerly there existed an Art Section, but unfortunately it fell through. A Literary Section should I think, receive wide support, and I take the opportunity of recommending the matter to the consideration of Mr. Burge, Mr. Hamlet, and Professor David, who, I believe, have been very active members of the Home Reading Union, the last named having been President for New South Wales.

Obituary.—The following is a list of the members who have died since the last Annual Meeting :—

Digitized by Google

Ordinary Members:

Elected 1896 Bridge, John
„ 1890 Eddy, E. M. G.
„ 1886 Hutchinson, W. A.
„ 1874 Lloyd, Hon. G. A.
„ 1884 Wiesener, T. F.

Mr. JOHN BRIDGE, one of Sydney's best known and respected commercial men, died at Stirling, in Scotland, on the 17th Oct., 1897. By his death the wool trade of the colony has lost one of its most representative men. Mr. Bridge, who at the time of his death was about sixty-six years of age, was born at Wollombi, near West Maitland.

Mr. E. M. G. EDDY.—During the year under review there passed away a gentleman whose death can only be referred to as a national loss, I mean Mr. Eddy, late Chief Commissioner for Railways, who died at Brisbane on the 18th July, 1897, at the early age of forty-six. Mr. Eddy was born in July 1851, and started his railway career at fourteen years of age, when he entered the service of the London and North Western Railway Company; he rose step by step, until in 1885 he reached the position of Assistant Superintendent. In 1887, owing to the illness of the chief officer of the Caledonian Railway, Mr. Eddy was made Assistant Manager in that company, an appointment which he filled so creditably that in August 1888 he was offered and ultimately accepted the Chief Commissionership of the New South Wales Railways, on the express stipulation that he should be allowed to exercise a free hand. The difficulties which Mr. Eddy had to contend with, the abuse to which he was subjected, and the jealousy with which his every action was scrutinised and commented on, and the indomitable courage with which he faced and overcame them are so well known that it is unnecessary for me to dwell on them. Suffice it to say, that he brought to a successful issue the great work for which he was appointed, and placed the railways of this Colony on a footing which makes them the one bright example of paying railways amongst

Digitized by Google

the great systems of Australasia. The permanent way and rolling stock were largely renewed, and the net revenues during Mr. Eddy's term of office increased from £765,000 in 1888 to £1,322,000 in 1896. Rates and fares were reduced during the same period, and the status and pay of the staff were materially improved. The Railway Institute is a lasting memorial of the constant thought the late Chief Commissioner gave to the welfare of the employés, and when he died he may truly be said to have earned the affection of his subordinates, the respect of his colleagues and the confidence and gratitude of the people of the Colony to to which he ungrudgingly devoted his mature experience and his splendid talents.

Mr. W. A. HUTCHINSON.—The death of Alderman Hutchinson of the Glebe, occurred June 20th, 1897, and the news was received with wide spread regret. Mr. Hutchinson was a well-known figure in municipal circles. For a number of years he occupied a seat in the municipal council of Balmain, and for two years was mayor of that borough. For nine years he has occupied the position of alderman in the Glebe Council, and during last year he filled the mayoral chair. At the time of his death Mr. Hutchinson was a vice-president of the Municipal Association of New South Wales, and no more energetic municipal worker was to be found. It is not surprising to find that his energy led him to enter political life. Indeed it would have been surprising had it been otherwise. Before the passing of the present Electoral Act the deceased gentleman was one of the representatives of Balmain in the Assembly, and whenever he spoke in the House it was generally felt that he had given deep study and careful consideration to his subject. Kindly and warm-hearted in disposition his face was welcomed everywhere, and his many acts of private charity gained for him hosts of friends. As a director of the Deaf and Blind Institute, and by means of his influence and active co-operation with many philanthropic societies and institutions, he was enabled still further to give vent to that charity which was within him. Mr. Hutchinson was a thorough business

Digitized by Google

man, and at the time of his decease was managing director of the Hetton Colliery, in addition to being on the directorate of several other coal-mining companies. Mr. Hutchinson always took the deepest interest in the work and welfare of the Society.

The Hon. G. A. LLOYD, M.L.C., is another member of our Society whose death during the year I regret to have to record. Mr. Lloyd was born at Norwood, England, in 1815, and came to New South Wales in 1834. He engaged in commercial pursuits and was prominently connected with the export of gold and the mining interests generally, whilst the part he played in settling the great strike at Newcastle in 1889 will not soon be forgotten. Mr. Lloyd for many years was a notable figure in the political world, and served under the late Sir Henry Parkes at different periods as Postmaster General, Minister for Mines and Colonial Treasurer. In 1887 he was appointed to the Legislative Council, and remained a member of that body until his death on the 25th December, 1897.

Mr. T. F. WIESENER, another member of this Society, died of dilatation of the heart, on the 1st June 1897, after a short illness. Mr. Wiesener took a very warm interest in the affairs of the Society more especially in regard to the Microscopical Section, and was most regular in his attendance at its meetings. His loss is very much regretted by those who knew him.

Mr. WHITTON.—While bringing before the members the names of those whose death we have to deplore, it will be a fitting opportunity to refer briefly to one who, though not a member of our Society, was at one time a prominent citizen, and whose career was intimately connected with the progress of this colony. I refer to Mr. John Whitton, my predecessor in the Government service, late Engineer-in-Chief for Railways, who died after a comparatively short illness on 20th February last. Had more time been spared to me, I should have been tempted to bring before the members a short account of the history of railways in this colony, with which he was so thoroughly identified. It would be interesting to show how Mr. Whitton had to fight and struggle

Digitized by Google

from the commencement with ignorance and obstruction—how he successfully contended for uniformity of gauge in the colony and only failed to persuade the Government to combine with Victoria for one standard gauge. At a time when money was scarce he still managed to get railways and not horse tramways for the country extensions, and adopted a location which, although it may not be in all details that which we should choose at the present day, was certainly the wisest in those times, when the traffic over the Blue Mountains was only an average of forty tons daily as compared with the present enormous amount. Mr. Whitton's steadfastness of character and fearlessness in maintaining what he considered right, were well known. At the beginning of June, 1889, he obtained leave of absence for twelve months on full pay and left for England. His health not improving he sought his retirement, but he some time afterwards returned to Sydney and enjoyed good health till shortly before his death an attack of jaundice seized him which eventually proved fatal.

Papers read in 1897.—During the past year the Society held eight meetings, at which the average attendance of members was 30·5, and of visitors two, the following twenty-four papers were read :—

1. President's Address, by J. H. Maiden, F.L.S.
2. On the Crystalline Structure of Gold and Platinum Nuggets and Gold Ingots, by A. Liversidge, LL.D., F.R.S.
3. A Contribution to the Study of Oxygen at Low Pressures, by R. Threlfall, M.A., and Florence Martin.
4. Determinations of the Orbit Elements of Comet *f* 1896 (*Perrine*), by C. J. Merfield, F.R.A.S.
5. Apparatus for Ascertaining the Minute Strains which occur in Materials when Stressed within the Elastic Limit, by W. H. Warren, Wh. Sc., M. Am. Soc. C.E., M. Inst. C.E.
6. The Theory of the Reflecting Extensometer of Prof. Martens, by G. H. Knibbs, F.R.A.S.
7. The Burbung, or Initiation Ceremonies of the Murrumbidgee Tribes, by R. H. Mathews, L.S.

Digitized by Google

8. Totemic Divisions of Australian Tribes, by R. H. Mathews, L.S.
9. On the Saccharine and Astringent Exudations of the "Grey Gum," *Eucalyptus punctata*, DC., and on a Product allied to Aromadendrin, by Henry G. Smith, F.C.S.
10. On the Essential Oil and the presence of a Solid Camphor or Stearoptene in the "Sydney Peppermint," *Eucalyptus piperita* Sm., by R. T. Baker, F.L.S. and Henry G. Smith, F.C.S.
11. Outburst of Springs in Time of Drought, by W. E. Abbott, Wingen.
12. The Possibility of Soaring in Horizontal Wind, by Lawrence Hargrave.
13. On a Cordierite-bearing Rock from Broken Hill, by J. Collett Moulden, A.R.S.M., F.G.S. (Communicated by E. F. Pittmann, A.R.S.M.)
14. Icebergs in the Southern Ocean, No. 2, by H. C. Russell, B.A., C.M.G., F.R.S.
15. Aurora Australis, by H. C. Russell, B.A., C.M.G., F.R.S.
16. On "Grey Gum" (*Eucalyptus punctata*, DC.) particularly in regard to its Essential Oil, by R. T. Baker, F.L.S., and Henry Smith, F.C.S.
17. The Effect of Temperature on the Tensile and Compressive Properties of Copper, by Professor Warren, M. Inst. C.E., M.Am. Soc. C.E., Wh. Sc., and S. H. Barraclough, M.M.E.
18. Notes on the Basalts of Bathurst and the Neighbouring Districts, by W. J. Clunies Ross, B.Sc., F.G.S. (Communicated by J. H. Maiden, F.L.S.)
19. On the Steady Flow of Water in Uniform Pipes and Channels, by G. H. Knibbs, F.R.A.S.
20. Experimental Investigation of the Flow of Water in Uniform Channels, by S. H. Barraclough, B.E., M.M.E., and T. P. Strickland, B.E.
21. Notes on Myrticolorin, by H. G. Smith, F.C.S.
22. A Second Supplement to a Census of the Fauna of the Older Tertiary of Australia, by Professor Ralph Tate, F.G.S., Hon. Memb., with an appendix on Corals by John Dennant, F.G.S.

Digitized by Google

23. Note on mutilations practised by Australian Aborigines, by T. L. Bancroft, M.B. *Edin.*
24. Note on the Occurrence of a Nickeliferous Opal near Tamworth, by D. A. Porter.

Sectional Meetings.—The *Engineering Section* held eight meetings, at which the average attendance of members and visitors was 20·5 ; the following papers were read and discussed :—

1. Annual Address to the Engineering Section, by C. O. Burge, M. Inst. C.E.
2. The Unification of the Methods of Testing Materials Used in Construction, and the Precautions Necessary in the Accurate Determinations of the various Coefficients of Strength and Elasticity, by W. H. Warren, M. Inst. C.E., M. Am. Soc. C.E., Wh Sc.
3. Note on the Cubic Parabola applied as a Transition to Small Tramway Curves, by C. J. Merfield, F.R.A.S.
4. Low Lift Pumping Machinery, by T. H. Houghton, A.M.I.C.E., M.I.M.E.
5. Belt Power Transmission with some new form of Brake Absorption Dynamometer, by Herbert E. Ross.
6. Tramway Rail Joints, by G. R. Cowdery.
7. Light-houses in New South Wales, by Henry R. Carleton, M. Inst. C.E.

The *Medical Section* held four meetings at which the following papers were read :—

1. On fifteen cases of Intussusception, by Dr. C. P. B. Clubbe.
2. On a Clinical and Pathological Criticism of Hereditary Ataxy and Locomotor Ataxy, by Dr. G. E. Rennie.
3. A note on the application of the Tuberculin test to Bovine Animals, by Dr. J. Ashburton Thompson.
4. Some recent work on the Cerebellum, its connections and functions, by Dr. George E. Rennie.
5. Notes on an interesting Cerebral case, by Dr. J. Adam Dick.

Reception.—A "Reception" was held at the Royal Society's House, No. 5; Elizabeth-street North, on Wednesday, July 14th. 1897. Mr. Henry Deane, M.A., M. Inst. C.E., President, presided,

Digitized by Google

The hall and staircase were decorated with ferns, palms, etc., kindly supplied by the Director of the Botanic Gardens. About one hundred and fifty guests were present; there were but few exhibits, inasmuch as the principal object of the gathering was to bring members and their friends together for a kindly chat and smoke.

Conversazione.—A Conversazione was held at the University, on the 14th January, 1898, in honour of the meeting of the Australasian Association for the Advancement of Science. Upwards of seven hundred members and guests were present.

Financial Position.—The Hon. Treasurer's Financial Statement shows a balance of £42 2s. 1d. carried forward, but against this is an outstanding account of £64 15s., which leaves the Society about £22 behind hand. In connection with this, however, it will be noticed that the cost of printing and publishing the Society's Journal for 1897 (Vol. xxxi.) viz., £384 7s. 6d. exceeds that of the previous year by upwards of £50, and is the most expensive volume yet issued, notwithstanding the fact that every possible effort has been used to keep down the cost of illustrations.

Library.—The amount expended on the Library during the past year was £151 0s. 11d., viz., £80 8s. 4d. for books and periodicals, £58 2s. 7d. for binding, and £12 10s. for pine shelving. Amongst other works purchased to complete series, may be mentioned the Transactions of the Ethnological Society, London, Vols. I. – VII., and the Journal of the same Society, Vols. I., II.

Exchanges.—Last year we exchanged our Journal with four hundred and one kindred Societies, receiving in return two hundred and forty-one volumes, one thousand four hundred and fifteen parts, eighty-three reports, eighty-seven pamphlets, ten hydrographic charts, a total of one thousand eight hundred and thirty-nine publications. The following institution has been added to the exchange list :—Field Columbian Museum, Chicago, U.S.A.

Original Researches.—In response to the offer of the Society's medal and grant of £25 for the best original paper on the following subjects :—

Digitized by Google

Series XVI.—*To be sent in not later than 1st May 1897.*

No. 52—On the Embryology and Development of the Echidna or Platypus.

No. 53—The Chemical Composition of the Products from the so-called Kerosene Shale of New South Wales.

No. 54—On the Mode of Occurrence, Chemical Composition, and Origin of Artesian Water in New South Wales.

No paper was sent in on any of the subjects.

With regard to the following, for which the Society offers its medal and ten guineas :—

Series XVII.—*To be sent in not later than 1st May, 1898.*

No. 55—On the Iron-ore deposits of New South Wales.

One paper has been received, but has not yet been adjudicated upon.

The subject for which the Society now offers its medal and ten guineas is as follows :—

Series XVIII.—*To be sent in not later than 1st May, 1899.*

No. 56—On the Life History of the Australasian Teredo, and of other species of Australasian wood-eating Marine Invertebrata, and on the means of protecting timber from their attack.

I now come to the second part of my address and submit a statement of some of the more important discoveries and events of the past year. In this account I have deemed it advisable to leave out medical practice entirely, and to confine myself chiefly to engineering, general mechanical and mining, and to natural science.

Part II.—Brief note of work done outside the Society during the past year, especially with regard to Australia.

Railway Commissioners' Department.—The following matter is worthy of special note. A fresh class of new stock—corridor cars—was added during the year, and the first instalment of the Australian consolidated engines, which are the most powerful in Australia, has arrived. This engine embodies the best qualities

Digitized by Google

of English and American engines, the weight of engine and tender together is one hundred and seven tons.

In the Permanent Way Branch attention is being paid to the improvement of grades and curves. A fact particularly worth mentioning is the completion of the renewal, in steel, of the timber approach to the Wagga Bridge. The process by which this was done was described in Mr. Shellshear's paper before Section H. of the Australasian Association for the Advancement of Science.

City Railway.—This important question has been advanced during the year. The question was referred by the Premier to a Royal Commission consisting of members of the Parliamentary Standing Committee on Public Works. After a lengthy inquiry the Commission recommended a scheme by which the terminus would be in the north-west corner of Hyde Park with its front to St. James' Road. Parliament afterwards referred the question to the Parliamentary Standing Committee, who after taking further evidence confirmed the previous recommendation. It may be hoped that the question is now settled, that a bill may be introduced to authorise the railway and that it may then become law.

An important step towards improving the means of transit in the city of Sydney is now being carried out by the construction of an electric tramway on the overhead system from the Circular Quay to the Railway Station at Redfern, and thence along Harris Street to the intersection of John Street, Ultimo. The power house is being erected at Ultimo between William-Henry and McArthur Streets, and adjacent to the Darling Harbour railway sidings, and will serve the purpose of containing not only the generating plant for the above mentioned tramway, but for the electrical power required for the conversion of the whole of the present steam system to electricity. The power plant will consist of four sets of horizontal cross-compound Corliss, surface-condensing engines, each of 1,200 H.P., and direct coupled to four 850 K. W. generators mounted between the two cranks. These are by far the largest generators in the Southern Hemisphere.

Digitized by Google

Ground has been provided for a further extension up to 20,000 H.P. The feeder cables are being laid in bitumen casings of the Callender-Webber type. The overhead wiring will be carried on solid drawn steel poles of the Mannesmann type, with ornamental wrought and cast iron brackets and mountings. These will for the most part stand in the centre of the roadway between the tracks. It is interesting to note that the Central London Electric Railway now under construction is being furnished with engines and generators of the same make and character as those already adopted here, and further that the Engineers have decided to use the Edison-Brown plastic bond for the rails.

High Carbon Rails.—Considerable trouble having been experienced owing to the softness of some of the tramway rails supplied a few years ago, I made an endeavour in 1896 to obtain from England a supply of rails in which the proportion of carbon was similar to what had actually been used in the United States, but I was not successful. On the advice of Sir John Fowler, a modified specification was agreed upon to which the rails were ordered.

Last year in consequence of the breaking up of the rail-pool, a favourable offer was received to supply American rails to a new specification prepared by me, and this was accepted.

The Railway Commissioners and the Public Works Department ordered 2,000 tons of 80 lbs. and 2,000 tons of 60 lbs. rails respectively. Since then English rails have been tendered for to the same specification. The proportion of carbon, etc. in the rails supplied has been as follows:—

	Carbon.	Silicon.	Manganese.	Sulphur maximum.	Phosphorus maximun.
1896	·45 – ·55, 83 lbs.	·10 – ·06	·95 – ·85	·08	·08
1897	·50 – ·60, 80 lbs.	·10 – ·15	·80 – 1·00	·08	·08
	·40 – ·50, 60 lbs.				

Harbours and Rivers Branch.—Mr. C. W. Darley, Engineer-in-Chief for Public Works, has furnished me with the following information:—A wharf wall is now being constructed round Darling Island of large concrete blocks. Hitherto all our wharves in Sydney have been built of either iron or timber, but seeing

Digitized by Google

that a good sound rock bottom was obtainable round Darling Island, at depths of from twenty-eight to thirty feet, it was decided to use concrete. The first cost will be higher, but when maintenance and reconstruction of a timber wharf in twenty-five or thirty years are taken into account, a large saving will be ultimately effected, besides which the design will admit of the use of heavy travelling cranes along the frontage. The blocks are all moulded on the island near the water's edge, the concrete being mixed in the proportion of four cement, nine sand, twenty-four broken sandstone, besides which large pieces of sandstone up to five and six cwt. are embedded in the concrete. The size of the blocks runs from seven feet by six feet by six feet to twelve and a quarter feet by six feet by six feet, and they weigh from fifteen to twenty-eight tons. Two holes for introducing lifting bars are moulded in each block. A steam derrick crane placed on a punt, capable of lifting about forty tons, is then used for handling the blocks.

At Jervis Bay a new lighthouse and full set of keeper's quarters are now being built at Point Perpendicular, the material used throughout for the walls being concrete moulded into blocks each to the exact shape required, and afterwards set in position.

Road Bridges.—Among the numerous contracts let during 1897 by the Bridges Branch, under charge of Mr. Darley, the most important was that for the timber-truss bridge over the Macleay River at Kempsey. This consists of four one hundred and fifty feet timber trussed spans on cylinder piers, with timber approaches, the contract cost being £18,300. The deck is twenty-two feet six inches wide between kerbs. This bridge is interesting for having the largest spans and being altogether by far the largest timber bridge in the Australian colonies.

During the year, the strength of the tension joint now employed in railway and road timber truss bridges in this colony has been tested at Cockatoo Dock, in a machine specially designed for this work by Mr. C. W. Darley, capable of exerting a pull of two hundred and twenty tons. The results of the tests made of full

Digitized by Google

sized joints with ironbark flitches, twelve by five inches, and fourteen by seven inches, prove the highest efficiency for this joint.

Monier System of combined concrete and steel construction.—It is well known that the above system has been somewhat extensively used for the construction of the sewerage aqueducts over Johnston's and White's Creeks. In August last year the arches were put to test, and it is satisfactory to find that the structures in both cases were entirely successful.

Purification of Sewerage.—Mr. Davis, Engineer for Sewerage Construction has furnished me with the following particulars :—In sanitary engineering perhaps the most important and certainly the most interesting development, is in the purification of sewage. When cheap land was available, conveniently situated, preference has been given to broad irrigation. When the area was sufficient, the soil suitable and the management good, excellent results were obtained, but where circumstances were not favourable, some other methods of dealing with the sewage requiring less land had to be looked to. Among these is the method known as precipitation and filtration. The sewage is allowed to flow into settling tanks, after in most cases having had lime, or some other chemical added to facilitate the precipitation of the suspended matter. The effluent passes from the settling tanks to the land, or into comparatively small artificial filters, composed of sand, breeze or other substances having the capacity of absorbing oxygen and allowing large quantities of sewage to pass through it without becoming clogged. In both these cases a good effluent can with care be obtained, but the working expenses are high.

The chief trouble and expense in the last named process has always been the treatment and disposal of the sludge taken from the precipitating tanks. In places near the sea-board it has been punted out to sea, but in other localities it has become necessary to use machinery to extract the liquid from the sludge, after which the latter has been either carted away for use by the surrounding farmers or disposed of in a destructor. It has been felt

Digitized by Google

for some time that any means of treating sewage without the production of sludge, would be hailed by sanitary engineers as a great advance on present methods.

Experiments have recently been made at Exeter, London and other places. At Exeter the Borough Engineer has constructed closed tanks, large enough for receiving a portion of the sewage from the town. The sewage flows into the tanks in an unscreened condition and remains there from twenty-four to forty-eight hours, according to the extent to which it is diluted by rain-water. When leaving these "Septic Tanks" (as they are called) it is found that an extraordinary change has taken place in the sewage. All the solids are broken up into very minute particles, the bulk becoming soluble. Distinct chemical changes have taken place by the aid of anaerobic germs, which under favourable conditions are present in the tank.

Running large quantities of sewage into tanks from which light and air are carefully excluded, would, one would think, have the effect of creating a great nuisance, but such is not the case. The gases generated in the tanks undergo chemical decomposition, so that when they are liberated they are not obnoxious. There is no sulphuretted hydrogen present, and the greater part of the gases which are given off are nitrogen, hydrogen and methane or marsh gas. The sewage when discharged from the tanks is a grey liquid with only a slight musty smell, and in such a condition as to be readily purified by filtration, either by passing it direct over land, or through filters of breeze or sand. The experiments show that typhoid germs have little chance of passing through the tank without being destroyed, and should they do so, they are in such a weak condition that they afterwards die.

Although the tanks are large, having a capacity for at least twenty-four hours average dry weather flow, no settlement takes place in them, and after twelve months use, only a thin layer of mineral ash was found. Should the method prove to be as successful as it bids to do, the whole difficulty of the sludge is overcome in a very simple way. The tanks at Exeter have been

Digitized by Google

working with most satisfactory results for upwards of a year, and now the town council has applied to the Local Government Board for power to treat the whole of the sewage on the same principle.

At the London outfall works very exhaustive experiments have been made with the effluent after it leaves the precipitating tanks. The liquid is allowed to remain in contact with the filtrant for a given period; it is next drained off as quickly as possible, so as to induce oxygen to enter the body of the filter, and give the latter a period of rest before fresh sewage is run in. These experiments show that it is possible to purify sewage to a sufficient extent to admit of its being turned into a flowing stream, after pasing it through breeze filters at the rate of 1,000,000 gallons per twenty-four hours per acre of filter. In other words the experiments prove that one acre of properly constructed filter beds will treat the sewage from 20,000 persons after it has passed through the septic tank, against say two hundred and fifty persons per acre if passed over land on broad irrigation lines.

The Minister for Public Works has approved of the Sewerage Branch of the Department of Public Works (on the recommendation of Mr. Davis, the Engineer for sewerage) erecting works for treating the sewage from the Rookwood Asylum on these improved methods. Should they prove to be a success it is intended to adopt them at two other places. The tanks and filters are arranged so that the whole process is practically automatic, the different valves being opened and closed, when required, by the aid of the sewage.

Low Level Sewerage of Sydney.—The Sewerage Branch of the Public Works Department has also during the last twelve months had to decide the best method of raising the sewage from the low level areas, on the foreshores of the harbour extending from Balmain to Rose Bay, to the gravitation sewers, as the sewerage system could not be deemed complete until this was done. The first area dealt with was the Double Bay valley, and it was decided here to use Shone's compressed air system. It was originally intended to drive the air compressors by steam, but seeing that

Digitized by Google

the Railway Construction Branch of the Department of Public Works was providing an extensive electrical plant at the Rushcutter's Bay Power House for the Rose Bay tramway, it was arranged to obtain the required power from the same source. The lifting plant is practically automatic, the motors being stopped and started as the air pressure varies.

The question of dealing with other larger and more important low lying levels has also been considered and the relative merits of the Shone system, hydraulic power and pumps driven by electric motors fully investigated. The Railway Commissioners undertook to supply what electrical power was required from the Pyrmont Power Station at one penny per Board of Trade unit, and at this cheap rate the conclusion arrived at was that from every point of view electrical power would be preferable.

From the calculations made it would appear that the relative cost per effective horse power hour would be as follows:—Electrically driven pumps 1·84d.; hydraulic system 1·85d.; compressed air 2·16d.

Sydney can claim to be the first city where electricity has been adopted for raising sewage. There will be nineteen stations, all controlled from the central station at Darling Harbour, the level of the water in the pump wells will be automatically signalled, so that the attendant at the head station will know when to stop and start the pumps.

Telegraphs and Telephones.—Mr. P. B. Walker, Engineer-in-Chief to the Telegraph Department, informs me that the most important construction work carried out by the Postal and Electric Telegraph Department in the city during the past twelve months, has no doubt been the extension of the underground tunnels and the laying of telegraph and telephone cables in them, which has already been the means of relieving the streets of a great number of poles and overhead wires. There are four main lines of tunnels branching out from the General Post Office to the north, south, east and west. The longest branch is that to the south, which

Digitized by Google

extends along Pitt-street as far as the Railway Station, and is intended to carry the main telegraph lines clear of the city, as well as the telephone lines connecting the southern portion of the city with the Central Telephone Exchange. The northern branch extends from the General Post Office to the Sydney Exchange at the corner of Pitt and Bridge-streets, and serves this important business centre with telephonic communication. The eastern branch runs viâ Moore and Castlereagh-streets to the top of King-street, where it will connect with an iron pipe conduit system, which carries it through to the Edgecliffe Post Office. The western branch extends from the General Post Office, Pitt-street side, along Martin Place, Barrack, Clarence and King-streets.

The tunnels, which are built of brick, are for the most part five feet six inches high and four feet six inches wide and terminate at the General Post Office in a large vault nine feet three inches high and nine feet wide, extending under the footpath of the Pitt street frontage. This vault is used for arranging the cables so that they may be brought into the cable terminal room in regular and proper order. It is here also that the cables are opened out, tested and prepared for laying. The tunnels are accessible at different points by means of shafts and man holes, covered on the street level with ornamental iron covers perforated so as to act as ventilators. Galvanized iron racks are provided in the tunnels for supporting the cables.

A considerable quantity of cable has already been laid in the tunnels, and the work is still going on. The cables are of the latest type with paper insulation and arranged for metallic circuits, each containing forty to fifty-two conductors. These conductors, which are of copper, No. 22 S.W.G., are each wrapped in chemically dried paper laid on spirally, forming what is termed a core, and each two cores are then laid up in a loose strand and afterwards laid up in groups of four. The whole of the cores are covered with a coating of cold drawn lead, which is protected by means of tarred jute.

Digitized by Google

Another work that was carried out during the past year was the establishing of a trunk telephone line between Sydney and Newcastle, a distance of about one hundred miles. A special line of thirty feet ironbark poles has been erected between McMahon's Point, North Sydney and Newcastle, for the most part following the railway line. Hard drawn copper four hundred pounds per mile has been used as a metallic circuit, with transpositions or crossings of the wires on the American system at every quarter of a mile. This is working most satisfactorily and is a great public convenience. The work of connecting Sydney and Bathurst by telephone has been started, and a communication between Sydney and Goulburn is also contemplated.

Whilst dealing with the matter of telephone lines generally it may be of interest to point out the fact, that a large number of wire fences in the country districts are being used by squatters and others for telephonic purposes. Thousands of miles of wire fences are connected chiefly for the purpose of giving communication between homesteads and out-stations on the various runs, and also connecting homesteads with the local post offices. These communications have been found to work very well in dry weather, but in wet weather the working is much impaired in consequence of the defective insulation.

The total number of telephones at present in use by the Postal and Electric Telegraph Department in New South Wales is 7,514, being an increase since the reduction of rates to subscribers on the 1st May 1896 of 4,100 telephones. The total number of miles of telegraph line is 12,745, and the total number of miles of wire erected 33,072.

As the use of electricity is likely to form so important a feature in the progress of the colony, it will be interesting to know something of the advance that has taken place throughout the world. Mr. Elwell has kindly pointed out to me that the following are the principal lines of progress in traction and lighting during the past year:—

Digitized by Google

1. Centralisation of plants, increasing size of units and reducing working expenses.

2. Combination of traction with lighting in order to keep up the load to a good average throughout the twenty-four hours.

3. Three-phase primary generation at high tension (5,000 volts.) with sub-stations where the pressure is reduced to any desired extent, and the current distributed locally. This effects a great economy in feeders, both leads and returns. It is adopted at the Central London Railway, the new stations in New York and Brooklyn and in Germany and Switzerland. "(I recommended this," Mr. Elwell says, "for Sydney in 1895, and we are fairly certain to adopt it when any extensions to the station are made, but the low tension system is the most economical as far as it goes, *i.e.*, with the four units now on order.)"

4. Three-phase traction on railways is fairly started on several small lines in Switzerland (Lugano, Gorner Grat, etc.) It offers the best solution for successful operation of suburban railways and any lines where the traffic is fairly continuous, and it is being watched with great interest.

5. Accumulators and boosters for both traction and lighting are largely increasing especially in America, but Manchester in England has one of the largest batteries.

6. Municipal ownership.—A strong tendency is now shown in municipalities to buy up lighting and tramways from private owners and converting the latter to electric traction, (*vide* Liverpool, Manchester, Leeds, Hull, Glasgow, London, Bristol, etc).

7. Electric motors for auxiliary purposes in power stations are rapidly increasing for cranes, pumps, fans, conveyances, etc., in place of small steam engines—with a saving in steam and attendance.

Mr. Elwell adds: "I have not touched upon telegraphy or telephones, but, as regards the latter, the necessity of complete metallic systems in any large exchange has been demonstrated at Glasgow (there are no electric trams there yet) by the recent Government inquiry."

Digitized by Google

Standard Datum.—During the year an important change has been made in the matter of the datum to which all levels taken by the various Government Departments are referred. In many years past a considerable amount of inconvenience and loss of time has been caused by the want of uniformity in this matter, each department having adopted a datum of its own, and in some cases even the different branches of the same departments had different values for the same bench mark. Confusion and trouble naturally followed this want of system, and as the evil became worse as time went on, a conference of the representatives of the various Government Departments was held, and after considerable discussion united action decided upon. Naturally it was agreed that mean sea-level should be the datum to which all levels should be reduced, and a table has been compiled giving the corrections to be applied to each Department's records to comply with this decision. The inscription on the brass plate attached to the bench mark on the northern wall of the Lands Office building has been slightly altered to agree with the value decided upon by the Conference, thus placing within easy reach a standard mark for future reference. In addition to this, the Conference recommended the establishment of automatic tide gauges at the various ports and harbours on the coast, and it is satisfactory to note that the Government have acted on this suggestion, and six tide gauges are shortly to be constructed for this purpose. When the registers are carefully examined and analysed, some most valuable scientific data should be the result.

Department of Agriculture.—I am indebted for the following to Mr. D. McLachlan, Under Secretary:—

The Agricultural Department, through its experimental farms and college has done much to advance the producing interests of the colony, and the total area under crop is now just twice what it was when the department was formed in 1891, *i.e.*, an increase under cultivation of nearly 900,000 acres.

At the Hawkesbury Agricultural College, Richmond, one hundred students are educated in the science and practice of

Digitized by Google

agriculture, and from records kept it is satisfactory to note that a large proportion of the students who have left the college are settled on the land and are doing good work in their respective districts. At the Wagga Wagga and Bathurst Farms, where a thorough practical training is given to lads, there are some twenty-five and ten resident students respectively, while these farms and those at Lismore and Pera Bore are visited by large numbers of farmers who are all anxious to see the results of the experiments carried on with new implements and new crops and by means of improved methods of farming.

At the Wagga Farm special attention is given to obtaining an improvement in seed wheat. By careful selection, wheats have been obtained which yield a considerable increase per acre over those previously produced. When it is realised that if by a gradual improvement in the class of seed used, the average yield for the colony could be raised even say one bushel per acre, and that this would mean an addition of £150,000 per annum to the wealth of the colony, the importance of this work can hardly be over-estimated.

Chemical Laboratory.—In addition to routine work which consists principally of analyses of soils, fertilizers, fodders and feeding stuffs, milk, water for irrigation and watering stock, sugar beets, insecticides, etc., Mr. Guthrie says, "we have been engaged in a continuation of the inquiry into the milling qualities of different varieties of wheat, the results of which have been published in pamphlet form. We are now having our mills run by power and in the course of a month we shall be in a position to pronounce upon the milling qualities of any sample of wheat on which an opinion is required. This should be a matter of general importance for at present the farmer has to take just what the millers care to give, and he has no means of commanding a higher price for a better grain. At present any improvement in the nature of the grain is impossible, as the growing of a new variety is attended by the risk that it may not turn out a good milling wheat, but this state of things will rapidly pass away. I have continued my

Digitized by Google

investigations into the nature of glutens, and summarized the results obtained in a paper On the Constitution of Gluten, read before Section B of the Australasian Association for the Advancement of Science. Mr. E. H. Gurney has made some original investigations into the waxes and colouring matters obtained from certain scale-insects, and has read two papers before the Chemical Section of the Australasian Association for the Advancement of Science on this subject." Mr. Guthrie is also engaged in compiling analyses of over one hundred soils of the County Cumberland, showing their chemical and physical characteristics and discussing their suitability for different crops and their general fertility. This he hopes to have ready for the May number of the *Agricultural Gazette*. A preliminary investigation into the action of lime on the soil has been also made; the results will be published about May or June.

Mr. Guthrie's programme for future work is of an extensive and highly important character, and includes matters which are every day becoming more essential to further agricultural progress. These are:—Investigations into the study of soil bacteria, the bacteriology of butter and cheese making, wine making and tobacco curing. In these already much has been done in Europe, but much still remains to be done. Further subjects for investigation are, the poisonous properties of plants poisonous to stock, the fodder value of native grasses and the conditions under which they thrive, and the use of manures.

Vine Culture.—Some interesting and valuable work has been done in this branch under Mr. Blunno. Steps have been taken so that the extirpation of the phylloxera may be considered to be well in hand as far as this colony is concerned, American phylloxera-proof vine cuttings have been imported, and are being experimented upon as to their suitability for different soils and their character under the various new conditions in which they are placed. Original investigations are being conducted as to the musts and wines produced in different districts of the colony, also as to certain wine "sickness" and experiments have been made with regard to fermentation and pruning.

Digitized by Google

Dairying.—Mr. O'Callaghan points out that this is an industry which is making great strides in this colony, and in order that our producers may be able to hold their own in the markets of the world, it is necessary that scientific methods should be applied in the manufacture and rating of the product. Attention has been given to Pasteurization, and the introduction of this method, which obviates the use of preservatives and the consequent exclusion of butter so treated from the British market, should be encouraged. Tuberculosis is a disease which is far too prevalent among cows, and Mr. O'Callaghan strongly advocates the use of the tuberculin test in all doubtful cases, and is about to submit this disease to experiments which from the nature of the case will be somewhat extensive. Mr. O'Callaghan further points out the necessity of establishing a central laboratory for bacteriological research and for veterinary purposes. The importation of a number of dairy stock of the various well known breeds, with a view to improving the cattle in the colony, has been resolved upon by the Minister for Agriculture.

Entomology.—Mr. Froggatt, Government Entomologist, supplies the following:—During the year nine articles have appeared in the *Agricultural Gazette* dealing with Economic Entomology.—A series of papers (4). "Forest Moths that have become orchard or garden Pests," I. – IV.; "Entomological Notes," dealing with several rare or destructive insects; "Fruit Fly Maggot *(Tephrites Tryoni)*; "White Ants, their habits and depredations"; "Insects on the Northern Rivers"; "San Jose Scale, *Aspidiotus perniciosus*"; "Coccids in Sydney Gardens." All these papers are illustrated with careful drawings made from living insects by the artists of the department. Investigations have been carried out on the life histories of many of our common insects, such as the case moths, vine moth, fruit fly, San Jose scale, etc.

Several consignments of humble bees have been imported from New Zealand, and liberated in various parts of New South Wales during the winter, but no reports have yet been received as to how they are getting on. Large additions have been made to the

Digitized by Google

economic insect collections. The collection of scale insects, which has been lately enriched by an aquisition from the Entomological Division of the U. S. Department of Agriculture, is the largest named series in Australia.

Pathology.—The scope of the work of the pathologist is well represented in the publications marked on the back of the pamphlet on the sheep-fluke. It may be said that each year we are learning very much more about the exact qualities of the various varieties of wheat, knowledge which promises to be of much value to the great wheat industry of the world. The pamphlet on abandoned orchards has done something towards awakening public opinion on the subject of plant diseases and assisted in obtaining the new measure now in force. The experiment work on the relation of manures to wheat growing are now complete, and will prove of great value to the dry wheat growing districts of Australasia. Most of these articles have been reviewed or reprinted *in toto* in leading European and American Journals. Larger and more important works are now in press embodying also the work of 1897.

Mining Notes for 1897.—Although every branch of metalliferous mining in New South Wales has been fairly active during the year, special attention has been directed to the working of, and to the search for payable copper lodes. The price of this metal has considerably increased during the year, due doubtless to the extension in the use of electricity as a traction power, and the consequent increased demand for pure copper wire. The Cobar, Nyngan and Captain's Flat districts contain the most extensive cupriferous lodes yet discovered in the colony. The introduction of the Water Jacket Furnace in copper smelting operations has been a feature of the year. Large metallurgical plants have been erected at Cockle Creek and Illawarra. The Broken Hill Proprietary Co. has also erected smelting works at Port Pirie, and the Government small, but complete metallurgical works at the Clyde, to which the cyanide process has recently been added. The action of the Government in resisting the attempt to create a cyanide

Digitized by Google

monopoly in this colony, has resulted in the successful introduction of the process on many of the New South Wales gold fields. The output of coal during the past year from our mines was the largest on record, and the quantity shipped to foreign ports exceeded anything since the opening of the fields in 1829, showing that this colony has little to fear from Japanese competition, where very extensive deposits of coal are being cheaply worked. The commencement of sinking operations by the Sydney Harbour Collieries Company Limited, Balmain, is worthy of passing notice. This valuable seam is expected to be tapped about three years hence, at a depth of some 3,000 feet. The development of this seam at such a great depth, will be watched with interest by scientific men.

Geological Survey of New South Wales.—During the past year Mr. E. F. Pittman, Government Geologist, in addition to directing the work of the Geological Survey Staff, sat as a member of the Royal Commission on the Spontaneous Combustion of Coal Cargoes and in conjunction with Professor Threlfall issued a report on that subject. A considerable amount of field work was also done in connection with an examination of the Gunnedah coalfield, and together with Professor David, a geological survey was made of the country around Tamworth. This work was of great interest owing to the abundant occurrence and great thickness of radiolarian schists, limestones and claystones, and also of the great development of sill structure. With regard to radiolarian rocks Professor David says:—"It has been proved that a great part of the Dividing Range from the Jenolan Caves to Barraba is composed of radiolarian remains. The radiolarian beds are about 9,000 feet thick and radiolaria are present throughout the series in the proportion of about one million to the cubic inch." Mr. Pittman further informs me that the district around Tamworth contains rocks belonging to both the Carboniferous and Devonian systems, and there is no doubt that the working out of the tract between Tamworth and Somerton will greatly simplify future geological work by establishing definite horizons. Mr. Pittman

Digitized by Google

also made an official examination of some of the West Australian goldfields, giving particular attention to the telluride-bearing ore bodies.

Mr. J. E. Carne, Geological Surveyor, completed the examination of the country along the New South Wales-Victorian Border, as far as the head of the Murray. This work though unsuccessful from an economic point of view, was of great interest, as it proved the occurrence of Lower Silurian graptolite-bearing slates and Devonian fresh-water sandstones in new localities. An examination was also made of the Wolumla District, where the gold-bearing rocks consist of impregnated patches of crushed granite and sedimentary rocks. Some of the sedimentary rocks are of Devonian age. Mr. Carne as well as reporting on other districts, also prepared two reports on our mineral resources, dealing with tungsten and chromium.

Mr. T. B. Jaquet and Mr. J. A. Watt, Geological Surveyors, made a complete examination of the Captain's Flat ore deposit, and submitted a report dealing with it. Mr. Jaquet as well as performing a considerable amount of routine work, also reported on the Elsmore Valley deep tin lead and on the Port Macquarie Cobalt Deposit. Here the cobalt occurs in serpentine and in the clay formed by the decomposition of the serpentine. The ore occurs in nests or pockets which are irregularly distributed.

Mr. J. A. Watt, who was appointed during the year, made in conjunction with Mr. Jacquet the examination of Captain's Flat already referred to, and also reported on the supposed diamond-bearing drift at Upper Tarlo. There the drift consisting of sand and gravel occurs under basalt, and it was from a shaft sunk to the bottom of the gravel that the diamond was said to have been found. Gold also occurs in the drift. Mr. Watt also reported on a deposit of iron ore at Carlo's Gap, and on the Nanima Creek and Gooda gold-fields.

Since Mr. Carne's discovery of Lower Silurian rocks on the Victorian Border, slates of the same age (as proved by their con-

Digitized by Google

taining characteristic graptolites) have been collected at The Myall, between Dubbo and Peak Hill, by Mr. F. Danvers Power, F.G.S. Lower Silurian Rocks had not been recognised in New South Wales prior to 1897, and their occurrence in two localities so remote as those referred to points to the probability of their being found to cover a considerable area of the colony.

Artesian Bores.—Mr. J. W. Boultbee has furnished me with some most interesting particulars of the work done in this direction, but they are too extensive to include in this address, and I have asked Mr. Boultbee to submit his account to the Society in the usual way at one of the monthly meetings. Mr. Boultbee shows how in America the presence of artesian water has been the cause of the growth of a large population in otherwise dry districts, and predicts a similar result in New South Wales. The work of boring, both public and private, has progressed rapidly, but there is still an enormous proportion of the 60,000 miles of country proved to be water-bearing untouched and unexplored by the drill. The number of Government bores completed to date is sixty-six, the total depth driven 137,589 feet, and the approximate output 30,674,500 gallons daily.

Water Conservation in New South Wales.—The two events of greatest importance in regard to water conservation during 1897 were the commencement of the operation of the Water Rights Act, and the submission of the report of Colonel F. J. Home, R.E., C.S.I. The Water Rights Act defines the rights of the State and of individuals to natural supplies of water and provides a system of licensing dams and other work, if no reasonable objection to their work can be shown. The Act also provides for the construction of work for water conservation, irrigation and drainage by the Government in cases where the land holders to be benefited are willing to pay the interest on the outlay and the cost of maintenance. The Water Rights Act became law on 1st November, 1896, and between that date and 1st February, 1897, the number of applications received for licenses was considerably over four hundred. Up to the end of 1897 more than four hundred appli-

Digitized by Google

cations had been received. Formerly dams and other work for water conservation and supply on creeks and rivers existed on sufferance only, and this state of affairs had naturally a most injurious effect on the development of the country. Although the Water Rights Act has been little over a year in operation, its influence in encouraging the construction of a better class of work has already become apparent.

The report of Colonel Home endorses the conclusion previously arrived at by the Department, that the only New South Wales rivers for which it is practicable to construct irrigation canals of any considerable magnitude are the Murray and the Murrumbidgee. He considered that even in the cases of these rivers, large storage reservoirs are required to insure sufficient supplies of water. Colonel Home concurred in the practicability of the proposed canal on the south side of the Murrumbidgee, and also of the proposed canal from the river Murray at Bungowannah, six miles below Albury, and he recommended that the former project should be taken up first as its financial prospects appeared the more promising.

The Bourke Lock and Weir, which is the only work of its kind in the Australian colonies, was tested under all ordinary conditions during the past year, and proved perfectly satisfactory throughout. The weir consists of a series of moveable shutters which are dropped flat on the river bed when the river reaches navigation level and are raised again when the falling river reaches this level. The lock gates also are opened when the shutters are dropped, and closed when the shutters are raised. In a flood the works are entirely submerged, and as the river was widened at the weir level, the waterway is actually slightly more than it was before the works were constructed so that there is no acceleration of the velocity. It was decided during the last Parliamentary Session, that the question of locking the river Darling from Bourke to Wilcannia should be referred to the Public Works Committee.

Chemistry.—Mr. Hamlet, the Government Analyst, has supplied me with the following information:—Recent advances in chemistry

Digitized by Google

include further researches as to the nature of the newly-discovered substances helium and argon. Olszewski has attempted the liquefaction of helium obtained from cleveite, and although the low temperature of – 220° was attained, yet no sign of liquefaction appeared. Experiments by Ramsay and Travers fail to prove that the new gases are truly elementary bodies after all. Helium may consist of a pair of elements like nickel and cobalt. Sir Norman Lockyer considers it to be a mixture on spectroscopic observations of certain distant stars. The chemists base their experiments on fractional diffusion and although the work proves to be both complex and difficult, further research is needed in order to place helium and argon in their proper niche in the periodic system of elements.

The examination of a number of commonly recurring minerals by Hartley has led to the discovery of the fact that many of the rare elements, such as gallium, rubidium and thallium exist in iron ores and saline minerals hitherto passed unexamined.

Some remarkable facts have been brought to light by Professor Liversidge, who finds small quantities of the metal gold in unsuspected form of matter; over a grain of gold per ton was found in rock salt, kainite and Chilian nitre. Small quantities of gold were found in sea water and in certain sea-weed, kelp, etc.

A novel use of the telephone has been suggested by Erdmann, who proposes to apply the instrument to the chemical analysis of milk, wine, beer and salts in solution. Perhaps the most remarkable chemical event of the year was the liquefaction of fluorine by Moissan and Dewar. The gas becomes liquid at – 185°, and in this state, strange to say, has no action on glass.

In New South Wales the most notable work in organic chemistry was the separation of and discovery of eudesmol and myrticolorin by Messrs. Baker and Smith, of the Sydney Technological Museum which have been duly described in papers read before this Society. The labours of these gentlemen, which are now specially directed to the investigation of the exudations and products of the Australian vegetation, are of the highest value.

Digitized by Google

Botanic Gardens.—The Director of the Botanic Gardens informs me that during the past year he has made special efforts to improve the herbarium. He has received several thousand species by exchange with botanical establishments throughout the world, and also as the result of collecting tours made by his assistants and himself. The phanerogams are now, in spite of recent large acquisitions, fairly in order, and the same may be said of ferns. As regards the remainder of the cryptogams, especially fungi, mosses, lichens and algæ, the collection at present comprises over two thousand named species, and it is hoped that, in a very few years, the herbarium of cryptogams will approach in value that of the phanerogams. Mr. Maiden states that the present condition of the herbarium is largely owing to the self-denying labours of his assistants, Messrs. Betche, Forsyth, Camfield and Grant.

Australian Museum.—A much desired extension of the Museum premises took place by the building of new and commodious workshops, so constructed as to form a part of one of the future wings of the Museum. In addition a new and separate house was erected for the reception of the bulk spirit collection, whereby the danger from fire has been very much reduced. The publication of the Memoir on the Atoll of Funafuti has steadily progressed. Six parts have appeared during the past year, leaving only two more parts to complete it. The collections have been enriched by the acquisition of a fine meteorite from near Mount Stirling, West Australia, weighing a little over two hundred pounds, and a magnificent set of polished slabs representing the commercial marbles of New South Wales, prepared by Mr. W. Roberts, Clerk of Works, Bathurst.

Thetis Trawling Cruise.—A question which has been before the minds of those interested in our fisheries has had some attention bestowed upon it lately. At the instance of Mr. F. Farnell, M.P., the Government s.s. *Thetis* was lent for the purpose of testing the existence of the deep sea fishing grounds which had been emphatically asserted by some and equally emphatically

Digitized by Google

denied by others. Those of us who have read Mr. J. D. Ogilby's "Notes on Australian Fishes" in that useful little Hand-book of the Australasian Association will understand how important it is from an economical and gastronomical point of view to solve the question. To Mr. Farnell is due the credit of thus getting the necessary investigation attempted. The success of the expedition has been established, and we shall look forward to the final report on the results obtained.

Altogether during the different trips fifty-eight trials of the bottom were made. As might be naturally expected, many of them were failures, but more than half were successful, and of them twelve produced fish of good quality and high market value in large quantities. The localities tried were from the north end of Manning Bight on the north to Jervis Bay on the south, all within twelve hours steaming of Sydney.

The *Thetis* is not a suitable steamer for the purpose, but under the command of Captain Hildebrand most of the difficulties were overcome. The expedition has been a success, for it has proved (1) the existence of more grounds, and (2) the presence of more varieties of edible fish than it was supposed by many would be discovered, and (3) it has further proved that operations on level bottom with the otter trawl, with, against or across the current, can be smoothly carried on without risk.

While this work was proceeding the opportunity was not lost to extend observation into other departments of marine zoology, and it will be interesting to members to hear the following note written for me by Mr. Waite at Mr. Farnell's request. "At this early stage it is not possible to say much about the extensive collections made, but a few general remarks may be attempted. The fishes total about a hundred species; this comparatively small number is accounted for mainly by the large mesh of the trawl. This permitted to escape the smaller fry among which a zoologist would expect to reap the richest harvest. In parts the mesh was two inches, consequently whole basketsful of fish were lost; indeed the first indications of a successful haul were the numerous dead

Digitized by Google

gurnards coming to the surface and floating away astern. When whiting had been netted, large numbers were lost in this way. Many fish also escaped over the ground line in consequence of the ill adapted nature of the *Thetis* for trawling, the most valuable fish lost in this way were dories, but nannegai, boar-fish, leather-jackets and others also escaped.

"An iron-frame dredge fitted with a fine net, designed to secure smaller specimens, was lost at the first essay and contributed so largely to the extensive damage sustained by the trawl (to the bunt-line of which it was secured) that it was not deemed advisable to renew attempts with the duplicate carried. Whenever rocks were encountered, the fishes obtained were few in number and species, and most of those netted escaped through the large spaces rent in the net. On such occasions a rich harvest of invertebrates usually resulted, comprising comatulas, sponges, ascidians, gorgonias, crustaceans, etc.

"In eighty fathoms off Botany, between two and three hundred examples of the rare echinoderm *Phormosoma hoplocantha* were trawled, previously obtained only by the "Challenger" in deep water (410 – 1375 fathoms). Mr. Whitelegge, who has only had time to make the most casual inspection of the invertebrates, tells me that there are a great many additions to the known fauna of the coast and doubtless a goodly number new to science, which he hopes he may have the opportunity of describing. With regard to the mollusca, being mostly small, they of course escaped through the large meshes, and it was only when sea-weed or rocks were encountered that much opportunity of collecting offered itself. The results however, so Mr. Hedley informs me, prove of exceptional interest. Many specimens of the magnificent *Voluta mamilla*, the first recorded in so low a latitude, were obtained. What appears on a casual inspection to be a *Brachiopod* new to science and a sea slug obtained for the second time in half a century, are other noteworthy captures. Experiments were also made with tow nets designed to secure pelagic or surface swim-

Digitized by Google

ming organisms, and those secured at night quite illumined the glass vessel in which they were received."

Funafuti Coral Boring Expedition.—It is scarcely necessary to give a detailed account of this work. We all know how much has been achieved by Professor David himself, who personally undertook the conduct of last year's expedition. It has been described by the Professor at the meeting of the Australasian Association for the Advancement of Science. The total depth which the borer reached was six hundred and ninety-eight feet. The material passed through appears to fall into three zones: the first reaching down to two hundred feet; here the material seems to be true coral reef to a depth of about fifty feet, with occasional coral heads *in situ*, and coral rubble to two hundred feet. The second zone reached down to three hundred and seventy feet; here sandy material distinctly predominates and coral fragments and rubble occasionally appear, and now and then a few isolated corals. The mass is not reef, although obviously produced in the vicinity of a reef, probably chiefly a reef rubble. Below three hundred and seventy feet is the third or lower zone. The character of the material suggests that it has been formed in the immediate vicinity of a reef which has occasionally, if not continuously, grown out laterally.[1]

Professor David's later comments are "Later examination shows that the supposed thin reefs are in reality bands of coral rubble cemented locally by chemical action by the growth of nullipores and other organisms, also since the examination of this portion of the core in Sydney (that is of the third zone) it would seem to be an aggregation of skeletons of deep sea organisms in coral rubble." Further he says, "The rock at the deep sea level is quite different from that formed by the growth of the true reef building corals in the shallow water. It appears to be formed of coral fragments cemented by various deep sea organisms, the nullipore playing an

1 See summary of Professor David's Preliminary Report Royal Soc. Proc., Vol. LXII., communicated by Professor Bonney.

Digitized by Google

important part in helping to consolidate the rubble." Professor David in a letter to me says "The core is being worked out in London by experts under Professor Judd, and in Sydney University by Messrs. Woolnough, Poole and David, and a geological map and part of the atoll is being prepared by Mr. G. Sweet of Melbourne. There is sufficient material already collected to throw very great light on the mode of the origin of atolls: but in order to try and settle the controversy definitely we are arranging for a third expedition to leave Sydney for Funafuti shortly to finish the bore on the island, and to put down a bore in the lagoon." For this purpose the Government Works Department are lending the necessary plant for boring in the lagoon, and the party will be conveyed to the scene of action by H.M.S. *Porpoise;* while the Government Department of Mines are lending a diamond drill plant to complete the six hundred and ninety-eight feet bore. The party will proceed to Samoa by mail steamer, whence they will be conveyed to Funafuti in the London Missionary Society's steam-yacht *John Williams.*

New Colony Map.—Mr. Twynam, the Chief Surveyor of the Department of Lands, informs me that a new map of the colony of New South Wales has been constructed in the Survey Branch of his Department, and will shortly be published; it is to the scale of eight miles to an inch, and the size of the mounted map will be about nine feet six inches by seven feet six inches: the construction is on a conical projection, and is based upon points determined by astronomical observation at stations on the main telegraph lines, an eighteen inch altazimuth instrument being used, and the longitudes determined by time signals from the Sydney Observatory, with which is incorporated the triangulation so far as it has extended, *i.e.*, over the southern counties of the eastern watershed, and say a hundred miles westward thereof. The map was designed with a view to engraving, which, it is hoped, may be accomplished in due course; it will then be a fitting accompaniment to the fine engraved maps of the colony of Victoria and Continental Australia, which were both produced in the

Digitized by Google

Lands Department of Melbourne. For immediate use in the public offices a photo-lithograph to the same scale has been printed. It may here be stated that a photo-lithograph to the same scale as the original map is rather a troublesome process in the printing, on account of the minute detail.

It is needless here to enter upon the importance of accurate territorial maps; these are absolutely necessary for the manifold purposes of government, *e.g.*, administration of the public estate, postal and telegraphic services, parliamentary electorates, public works and local government divisions. This necessity is recognized in all civilized countries, and as an instance the beautiful territorial maps of America may be mentioned, which are published and sold at very low prices. It is to be hoped that in due course the map referred to may be engraved, and may be widely distributed throughout our public institutions and offices, not forgetting the instruction of the youth of the country in the public schools; and thus one of the objects may be attained which justify the publication of geographical maps by the State.

Observatory.—Mr. Russell informs me that there has been no original investigation during the past year, as the additions to the ordinary work have taken up the few hours that he used to have to spare for other investigations.

The New South Wales Branch of the British Astronomical Association with its head quarters in Sydney—now in the fourth year of its existence—still continues to do useful work under the presidency of Mr. G. H. Knibbs, F.R.A.S. Having for its object the advancement of a popular interest in astronomy, and the formation of sections to study different branches of the science, regular monthly meetings are held and papers are read and discussed. During the past year the Jupiter, cometary, meteoric and solar sections were active, and the observations obtained were forwarded to London for discussion by the directors of the sections of the parent association.

Mount Kosciusko Observatory.—Mr. Wragge has successfully established a mountain experimental observatory on the summit

Digitized by Google

of Mount Kosciusko, 7,328 feet above sea level, also a sea level station on its south-east coast adjacent, at Merimbula where simultaneous observations are taken. The hours are midnight, 4 a.m. and 8 a.m., noon, 4 p.m. and 8 p.m., also half-hourly from 8·30 a.m. to 11·30 a.m. inclusive. Simultaneous readings are also taken at a new station in Sydney, at Sale in Victoria, and at Hobart and on Mount Wellington, Tasmania.

Antarctic Research.—Attention is being again directed to this important matter. During the Jubilee proceedings in 1897 the Royal Geographical Society arranged for a conference of Colonial Premiers and others, with a view to ultimately obtaining Australian co-operation, and the Society has further appealed to Lord Salisbury to assist in carrying out the object. A special meeting of the Royal Society to discuss the question was held on February 24th last, presided over by Sir John Evans in the absence of Lord Lister through illness. The proceedings began with an able address by Dr. John Murray, explaining the extent of our present knowledge and the scientific results to be looked for by renewed exploration, and he was followed by the Duke of Argyll, Sir Joseph Hooker, Dr. Nansen, Dr. Neumayer, Sir Clements Markham, Dr. Alexander Buchan, Sir Archibald Geikie, Mr. Sclater, Professor W. D'Arcy Thompson, Admiral Sir William Wharton and the Chairman. To us in Australia this matter is of special interest, and it is to be hoped that the Australian Governments will give their assistance, not only moral but pecuniary, to the movement.

Technical College, Ultimo.—Dr. Morris, Superintendent of Technical Education, has furnished me with the following particulars. A new branch has been established at Broken Hill, for the purpose of teaching chemistry, geology, mineralogy and assaying. The Technical College has lost the valued services of Mr. W. A. Dixon, who has resigned. A rearrangement of subjects has been introduced, which, it is anticipated, will prove highly beneficial. The Rev. J. Milne Curran directs instruction in chemistry, geology, mineralogy, metallurgy and assaying, and a

Digitized by Google

practical course in mining is given. Dr. Morris informs me that the available space in the college is already inadequate for the great variety of subjects which require to be taught to make the whole range of technical education complete, and requests to take up good work have sometimes to be refused. The work of the college is chiefly utilitarian in character, but its scientific basis is always receiving increased attention.

P. N. Russell Scholarship.—"In 1896, Peter Nicol Russell, Esq. formerly of Sydney, but now living in London," to quote the University Calendar, "presented to the University a sum of £50,000 for the endowment of the Department of Engineering in the University," under certain conditions which were namely:—(1) That the Department of Engineering was henceforth to be called the P. N. Russell School of Engineering; (2) That out of the income of the said endowment practical and theoretical instruction were to be given in mechanical engineering, surveying, mining, metallurgy and architecture; (3) Certain restrictions in applying the money to expenses already incurred. The Senate have now the matter well in hand, a portion of the money has been devoted towards the cost of lectureships, and a scholarship has been founded of the value of £90 per annum, to be competed for by applicants who shall have qualified themselves by a certain amount of preliminary theoretical and workshop training. The successful candidate will thus be assisted in following up the B.E. course in mechanical engineering. There is a marble bust of Mr. P. N. Russell in the Hall, and he has been asked by the University Senate to allow his portrait to be painted and placed there. A metal die has been made for a gold medal (£20) to be awarded annually for distinction in engineering work, but the exact conditions of the award have not yet been determined. The medal has upon it a very fine portrait of Mr. Russell.

Biology.—The Manual of Zoology of Professors Parker and Haswell deserves special mention. It is a work of great industry and scientific importance, and being up to date it is a most useful book of its kind. The death of Professor Parker on the

Digitized by Google

7th November, 1897, in the prime of life, is an event much to be regretted, as in him Science in the Southern Hemisphere has lost a most zealous student and able worker. Several papers of special Australian interest have been published in England, and being such it would appear proper to make a reference to them here. Among these are papers by Dr. Robt. Brown on the Morphology of Jacobsen's organ in Mammalia, and by Mr. J. V. Hill on the Placenta of *Parameles*.

Macleay Bacteriologist.—The bequest of Sir William Macleay for the purpose of endowing bacteriological research, which, although accepted with the imposed conditions by the University was afterwards returned by that body with the sanction of the Court of Equity, was taken up by the Linnean Society of New South Wales and recently the appointment of a bacteriologist has been made. It will be known to some of us that the Council of the Linnean Society in 1896 offered the salary of £350 per year to the successful applicant—invitations having been issued to all parts of the world. The number of candidates forthcoming was not considered sufficient to make the Council sure that they could not do better if their objects were made more widely known. It was decided therefore to postpone the appointment, and after a time to advertise afresh and raise the salary to £400. At the end of last year fresh applications were received, and after considerable deliberation two candidates were selected, and ultimately Mr. Greig Smith, B. Sc. *Edin.*, M. Sc. *Durh.*, F.C.S., was appointed as Macleay Bacteriologist.

Communication with New Hebrides and other Islands.—It is of interest to record that a steam service has been started by Burns, Philp and Co., to the New Hebrides touching at Norfolk Island and Lord Howe Island. The service is to be subsidised to the extent of £1,200 by the Government of this Colony, and £800 by that of Victoria. Convenient access to these islands for scientific investigation will thus be afforded. With regard to the New Hebrides, it is to be remarked that "the French Government pay an annual subsidy of £16,000, and by this means they

Digitized by Google

settle people on the islands, and run an inter-island and a direct steamer to Australia. The Australian Company so far, has carried on nearly all the trade, but has to battle against many disabilities." The disabilities referred to are the fighting against the handicapping caused by the French subsidy, the restrictions against sale of fire-arms, as to the treatment of the natives and as to the acquisition of land, which seem to be very proper in themselves, but which British subjects alone appear to be liable to.

In the above account I have been obliged through lack of time to confine myself almost exclusively to the work of Government Departments, paying special attention to subjects of engineering, mining, and agricultural interest. It will be seen that I have not described the work done by other Societies, as their proceedings can be consulted. With regard to the Australasian Association for the Advancement of Science. it is probable that their proceedings will shortly be published, so that the necessity for my going into details is thus also obviated.

Part III.—The Australasian Association for the Advancement of Science held its seventh meeting in Sydney in January. Although the attendance was not so numerous as might have been hoped, the gathering was a distinct success. A large number of papers were presented and read; some were of the greatest importance, while their character generally showed a great improvement over those of earlier meetings. One feature of this meeting was certainly the Presidential Addresses to the Sections, some of these being of special value, another was the evening lectures, one of which delivered free to working men was an innovation, and having proved a success is an example worthy of being followed in the future. Some of the papers read in the sections, such as Professor David's description of the Funafuti work and Mr. Pittman's account of his observations in Western Australia being of a highly popular character were largely attended.

Although some excursions were successfully carried out, it must be acknowledged that on the whole the excursion programme was

Digitized by Google

rather a failure. Whether this was due to the prevalence of hot summer weather, or whether there was any defect in the manner of bringing the proposed trips before the members, it remains a fact that many important excursions fell through. It is worthy of note that the greatest energy was displayed by the members of Section H.

A very enjoyable excursion almost of an impromptu character, considering the short notice at which it was got up, was to Wentworth Falls in a special train of the new corridor and Pullman cars generously provided by the Railway Commissioners.

In reviewing the proceedings of a meeting so successful as the last it will not be thought mere cavilling when it is pointed out that some improvements could probably be made in future. According to the views of some much more fitted to judge of the question than myself, there are too many papers submitted to the sections. At the start the secretaries are naturally anxious to get papers, and perhaps they take to themselves no little credit when they find they are making up a long list. The result is that the sectional work is heavy and the opportunities for members of different sections to meet one another are diminished. What seems to be more wanted are especially papers of a larger scope, which would interest members from different colonies at the same time, and such as, embraciug a larger field, would require the presence of members of more than one section at the discussion. Subjects, it has been suggested, might be given out and papers on them invited, so that a united conference or discussion on them might be arranged. I am given to understand that steps are likely to be taken to put this proposal into effect at the next meeting in Melbourne, and it is expected that Professor Baldwin Spencer will show some good results from his efforts in this direction. A great deal of good will be done by useful discussion of such larger questions, there would be better opportunities for members to meet one another and local societies would not be robbed of papers which should be preferably read before them, because chiefly of local interest.

Digitized by Google

Professor Liversidge informs me that the list of members at the Sydney Session was divided as follows between the different colonies :—New South Wales four hundred and seventeen, South Australia seventy-two, Queensland seventy, Victoria fifty-three, New Zealand forty-three, Tasmania fourteen, Western Australia six, and Fiji three, while Great Britain contributed three, total six hundred and eighty-one. Of these one hundred and three were ladies, derived almost wholly and in proportionate numbers to the male members from New South Wales, Queensland, South Australia and Victoria.

The number of papers read before the different sections were as follows :—A fifteen, B twelve, C seventeen, D thirty-one, E seven, F twenty-two, G—Economic Science eleven, Agriculture twenty, H thirteen, I five, J twenty, total one hundred and seventy-four.

Note on Work Done by the Association.—Encouragement of Science.—That the meeting was a success was almost entirely due to the forces within the Association, to the energy of the Permanent Secretary and present President and to the secretaries of the sections, and many other members who willingly aided in the work. Our city authorities afforded no encouragement—a very short-sighted policy, for the arrival in our midst of some few hundred visitors must, to say the least, have a certain effect on the trade and consumption of the place. That the visit of our scientific friends from the other colonies was not made the occasion for a welcome by the city authorities is a fact very much to be regretted, as Sydney now I believe, stands in this remarkable position, that although vaunting herself as the chief city of the Southern Hemisphere, she alone of all cities where the English tongue is spoken, has missed an opportunity of according to science the honour which is her due. In other colonies the Association has met with the greatest hospitality. The prototype of our Association, the British Association, has met annually for more than sixty years, in one or other of the important cities of the British Isles, with the exception of two occasions when the meeting was held in Canada, and year after year there is an

Digitized by Google

eagerness and competition among cities often much smaller than Sydney in the endeavour to secure the advantages of the presence of the Association at the next meeting. The American Association has I believe the same experience—everywhere welcome—and other science congresses of Europe and America can tell the same tale.

I am afraid that the attitude referred to is largely adopted by the public generally. I ask therefore to what is it due? The consideration of the question has led me to the following observations :—

There is a total misconception as to what science is. Many people fancy that it is a collection of fads, an unreality, an unpractical occupation which amuses perhaps in a harmless sort of way, but which is rather contemptible than otherwise. They connect it with the mere catching of butterflies, collecting way-side weeds or perhaps starfish on the sea shore.

There are other people who unless they see immediate gain to themselves are content to let others work in the field of science and lend no helping hand. As regards occupations they prefer those which, they say pay, and as regards amusement—well, they are quite satisfied with the usual outdoor amusements for which our climate is so well fitted and which do not fatigue the brain. Other people again look upon science as something very abstruse and beyond their comprehension.

The term "Science" embraces nearly all real knowledge, which goes to the culture of the individual, and especially systematic knowledge, and in repudiating science a man repudiates what really places him above the level of the savage. When he does so, he does not in fact recognise how much scientific knowledge he is himself in possession of, or to how much he is indebted to scientific work for the use and enjoyment of all those comforts which are supposed to make life worth living, and certainly are the chief instruments in raising our civilisation above that of the past ages.

Digitized by Google

Now as to the utility of science. If the dictionary is searched it will be seen that *Science* embraces all theoretical knowledge and *Art* is the application of it—science and art go together. How then can we have art without science? Art is eminently practical. Our Technical College, in conformity with the meaning of the term, is intended for the teaching of the various branches of art, and no one can complain that the classes there are not practical in their object and tendency. If this view is correct, science which is essential to right art must be practical also.

It is probable that people do not know what a range of subjects may be dealt with at a scientific meeting like that of the Australasian Association for the Advancement of Science. The titles of the sections are as follows:—A, astronomy, mathematics and physics; B, chemistry; C, geology and mineralogy; D, biology; E, geography; F, ethnology and anthropology; G, economic science and agriculture; H, engineering and architecture; I, sanitary science and hygiene; J, mental science and education.

Is it possible that any man or woman with any claim to intelligence cannot find among the above list some subject or subjects which he or she is interested in, and which he or she would like to gain information upon? I do not believe that any one would like to acknowledge that all these subjects are beyond their comprehension, and yet if they only took an active interest in one they might help the Association, and it is to be observed that the object and scope of the work of the Royal Society of New South Wales which should represent the chief scientific thought in this colony, is quite as wide as those of the Association which fills a similar role with regard to Australasia.

It is not pretended that the subjects thus included under the term "Science" are all those that go to make the culture of the individual. There is of course a great deal of knowledge besides and among these the study of language, literature and history, but even with regard to these it may be said that they closely concern sections F and J. Some aspects of language, such as the

Digitized by Google

comparative study of various languages and general history of races could well be brought under F, while literature and history can be considered in their educational aspect and can therefore be claimed by section J.

In fact so broad is the term "Science," and so unbiassed and so wide-reaching are the aims of the Association, that if the list of sections is not long enough a new one could be readily added to cover any new subject of interest that may be submitted to the Council of the Association, and what may be said of the latter body is all the more applicable to our Society, seeing that its objects are stated in the Act of Incorporation to be the "encouragement of studies and investigations in Science, Art, Literature and Philosophy."

There is evidently a much greater lack of the scientific spirit in Australia than in Great Britain, and Europe, and America. Why is it? Is it that people are too physically vigorous? As soon as their work is done, and sometimes before, their whole attention seems to be taken up with out-door games and amusements. Is it the bright sunshine and the attractions of the open air that leads to the cultivation of the physical and the neglect of mental culture? If people generally could only be awakened to the delights of a study of nature, they could enjoy the open air while learning some of the mysteries of the life around them, and still find time enough for healthy games and social amusements. Their own life would be enlarged to them, and there would be an additional pleasure in existence.

In this Nineteenth Century when the quality and cheapness of everything we use is so much the result of scientific thought and discovery, people ought to be better informed. Can they not be taught? Would it be possible to make a regular practice of giving public lectures? Could societies for the study of science at home, on the same basis as the home reading societies for literature be instituted? And is it possible not only to help educated people but the great masses of the people to learn something of the secrets of science? I think all these questions can

Digitized by Google

be answered in the affirmative, and that we as members of the premier scientific society of this colony, should do something more to bring about a better state of things.

I think we are bound, in the first place, to advocate the placing of science in a more prominent position in the education of the young. I do not in any way intend to depreciate the value of literary studies and languages, because it is certain that anything approaching a complete education cannot be arrived at without a grasp of literature and language, but the day has gone by when these were universally considered to be the only way in which the mind could be trained. It is now accepted by our best authorities that science answers exactly the same purpose, and it has this advantage that it leads to habits of observation and to a sharpening of the outward faculties which at the present day of competition must be of great utility, and that while the study of ancient languages and literature helps the retrospective faculties, with the aid of science man deals with the present and makes plans for the future.

It is very much to be regretted that men in high positions, when they make speeches at scientific meetings, should affect to despise science or say that they know nothing about it, and pass off their own ignorance with a laugh, as if it was not rather a matter to be deplored. Science is so wide in its scope that surely every man in a prominent position should have studied some particular branch of it.

Importance of Technical Training to all those engaged in the mechanical and manufacturing arts.—Few now dispute the importance of technical training. Much has been written and spoken on this subject in Great Britain during the last few years, and the question has been the subject of an important inquiry and report by a Commission appointed by the British Government. It is now acknowledged that the British manufacturer has allowed himself to be outstripped in manufacturing progress, because other nations, notably the Germans, have for a long time based their practice on sounder scientific knowledge. In their country

Digitized by Google

technical schools have been long instituted, and care has been taken not only to train men specially to undertake the chemical and other departments in manufacturing establishments, but to give opportunity to artizans to properly learn their trades on scientific principles.

Sound technical training implies a knowledge of theory, and the student must be carefully instructed in the principles which underlie his subject, if he is to be in a position to properly exercise his judgment. The necessity for this is clear. The trained man starts in the business of life with a grasp of his subject, a fund of information which the untrained man does not possess, and he is in a much better position to cope with difficulties and achieve success than the other.

The training of the skilled artizan and that of the professional man have this much in common. Both require a certain knowledge of theory in order to understand their work, although, of course, in the case of the latter the extent and range of subjects to be learnt is vastly greater than in the other case, and they both have to acquire a facility in manipulation in the particular instruments essential to their calling.

It cannot be too strongly urged, how important it is that all classes from employer to workman should be taught as their varying circumstances require, if the British race wishes to keep in the front.

With regard to the profession of engineering, it is not to be denied that the great engineers of the early part of this century started life without much theoretical teaching, and that their careers have been pre-eminently successful, but how much more transcendent would their position have been had they had the preliminary training which we now enjoy, but which in those days was not to be had? and it may be asked whether these great men would at the present time, did they enter upon their calling without it, be able, in spite of their genius, to compete with those who having less genius were better equipped. They certainly would

Digitized by Google

have been seriously handicapped, and it is not likely that they would have distinguished themselves above their fellows to the same degree.

The reality of the importance of properly instructing engineers in the ground work of their profession is now officially recognised by the Institution of Civil Engineers. An alteration in the by-laws has been quite recently effected, by which the council are empowered to require that all candidates for the associate-membership shall submit themselves for examination, the same to be dispensed with only if evidence of previous training of an acknowledged kind is forthcoming. Other qualifications such as experience have the same value as before. In the case of full membership application for entry will be most carefully scrutinised, and it is probable that it will not be long before the stamp of membership of the Institution will be looked upon as the greatest testimonial of competence, next to the carrying out of some great work, which the engineer will be able to show.

The above ought to be an encouragement to young would-be engineers, to enter the Engineering School at the Universities. I have not infrequently been asked to advise as to youths who wished to take up engineering, and I have invariably recommended a University training. It is of no use beginning at the wrong end. If a man tries to learn practical engineering first, and study the principles afterwards, he will have very great difficulty in acquiring the latter at all, he will not have time to devote to it, and he will always be seriously handicapped. All men are not equally endowed with common sense, and a certain untrained man may have more of that article naturally than some other trained man, but it is only the man who is properly taught who can correctly use his judgment and his reasoning powers. Those young men who have not studied the principles of their profession had better begin now. I fully believe that in a few years' time the untrained man will cease to be employed, or at least he will have little chance of rising.

Digitized by Google

I should like all who have sons or relations aspiring to be civil engineers to bear this in mind, and let it not be forgotten that the term "Civil Engineer" as defined by the Institution of Civil Engineers, applies also to the mechanical, electrical and mining engineer. There should be no back door entrance to the profession, and the man who attempts that method should have to content himself with the lower grades.

It is an advantage to our Public Service that the qualifications of all applicants are carefully scrutinised before employment. Even for junior clerkships the Public Service Board very properly arrange for examination before entrance. How much more necessary then for the professional candidate! With regard to the latter I hope the Board will see their way to give due recognition to University degrees, to forego the further unnecessary examination in the subjects in which the candidate has already qualified, and make their choice dependent on his general fitness and experience on actual work, while at the same time if the Public Service Act requires it, a thesis could be asked for on some set subject by way of examination.

I have urged the importance to the engineer of proper and sound training, but my remarks are in the main applicable to other callings,—certainly to the allied profession of architecture as well as more or less to all the manufacturing arts.

I should like to see the work already begun by that most useful institution, the Technical College, extended and enlarged. I believe that just as the University is fitted to deal with higher education in general and with the education of professional men, so the Technical College is the best body to teach in a practical manner the various branches of arts and manufacturing, while at the same time it includes sufficient theoretical teaching to enable the student to understand the groundwork of his subject. I am sure all will agree that the encouragement of this institution will prove one of the best investments the State has ever made. It does not matter what classes of the community are benefited, increase of knowledge in the individual, if widely extended, must

Digitized by Google

add to the aggregate of knowledge, and thus benefit the nation at large.

I wish to say a few words as to methods of teaching. Students of small classes like those in the Engineering and Medical Schools at the University, have an incalculable advantage over those who have to work in larger classes, as they have better opportunities of personally coming into contact with their teacher. Means can be adopted by the teacher by which the individual student's application to his studies can be tested from time to time. This seems to me a matter of very great importance. It can scarcely be denied that the object of a teaching institution is to teach, and not merely to lecture. If the chief object of a University were to test knowledge by examination, lectures might well be dispensed with, as after the course had been prescribed and text-books recommended the student might be left to himself or his coach, and it would be cheaper for him as he would have no class fees to pay. If an institution, however, undertakes to teach, every opportunity should be given to the student to enjoy the personal influence of the professor, his assistance, guidance and advice. This would result in some considerable supervision and authority over idlers, who ought to be made to realise the time and opportunities they are wasting.

In the English universities, where residence is required, a good deal of supervision is exercised, but in non-residential universities it is all the more necessary that the short hours during which the student is under control should be utilised to his best advantage.

Of course the University professor is dealing with young men who are supposed to have arrived at years of discretion. He cannot indeed treat them as school-boys, but he can call them to a sense of duty and encourage them. Even in the case of large classes, some means might be found by which the lecturer could inform himself of the progress being made by each individual student. Could the right influence be brought to bear, I am sure that we would not hear of the enormous proportion of first year students who fail to pass the year's examination. The young men

Digitized by Google

and women of the first year particularly require assistance—they have recently left school, where they were under constant control; they are now left to themselves, and for most of them the sense of freedom is too great; they are not strong-willed enough to give the attention to their studies that is necessary, and the best of them want some guidance.

Another question seems to me well worthy of attention. Some students, while showing fair proficiency in certain subjects fail in others when they come up for the year's examination, and they then have to enter all classes again the following year if they mean to persevere in their university studies. Why should they have to recapitulate those they had successfully passed? I admit that some restrictions must be enforced, but is it not a waste of time to have to attend lectures over again, and an unnecessary expense to pay fees in those subjects they have already passed in. Perhaps if the student's progress could be properly gauged from time to time during the year there would be fewer failures at the end.

I think it is acknowledged that in the second year of our Engineering School the extent of study prescribed is too great; what it would be were the classes large and the interest taken by the professors and lecturers less, I do not know, but in the School in question the personal influence and assistance of the teaching staff is very great, and the student finds his difficulties considerably smoothed down. I am sure it would be better to allow the student to divide the work of the year if he prefers to do so. What is to the advantage of the student is to the advantage of the university. To make the three years' course into a compulsory four years' course, might be too hard on the brilliant but not too affluent student, though it would suit the slower, more plodding, hard working student. As it stands at present if the second year man fails to make himself proficient in all subjects, he has to go over every one of them again another year, which is not only hard but in part waste of time and money. Could not the system be made a little less rigid?

Digitized by Google

Professor Liversidge, in his presidential address to the Australasian Association for the Advancement of Science, gave it as his opinion that the engineering and science courses should be of four years duration. I presume that this is recommended for the double purpose of securing more thorough work and also a higher standard. With regard to the work of the Engineering School in which I naturally take a special interest, I should like to see the studies so arranged, if spread over four years, that the first three years should be devoted almost exclusively to the teaching of principles and theory, while if thought desirable the study of special machines, questions of economy and cost could be dealt with in the fourth year; but I am not very much disposed to favor the teaching of matter which can better and more quickly be acquired after leaving the university, when the young engineer has entered upon his practical life. One great object would be gained by the lengthening of the whole course—the student would have more time for mathematics, and he would, as I think he ought, learn to use the calculus with as much facility as the unprofessional man uses the ordinary rules of arithmetic. He would also have more time for physics and chemistry, if found desirable, as well as for the engineering subjects properly so called.

I offer the above observations with all deference to those to whom has been entrusted the care of the higher education of our young men and women. I am convinced that these matters have by no means been overlooked by them, but it will not be out of place if I submit views, which are shared with me by men well competent in virtue of their position to form an opinion.

Before concluding, I wish to place on record my thanks for the kind assistance received from heads and principal officers of Departments and others, in collecting the information contained in my address.

It now remains for me to thank you for the consideration with which you have treated me during the time that I have occupied this chair, and congratulate you on the election of my successor, to whose able keeping I now have the pleasure of handing over the responsibilities of this high office.

Digitized by Google

"AERONAUTICS."

By L. HARGRAVE.

[*Read before the Royal Society of N. S. Wales, June 1, 1898.*]

SINCE the paper on the possibility of soaring in horizontal wind was read, no efforts have been spared to determine the essential features of curved surfaces that are of any practical utility to aeronautics, and the models shown in Figs. 1 and 2, embody what is known to date. The poles and horizontal cord have been found a most useful method of experimenting; indeed it may safely be said that without them the trifling amount of available wind would have been quite inadequate to find out anything new. As suggestions to those who wish to advance this matter rapidly, it may be stated that the wind near the ground is comparable to the surf on the sea shore, which all will admit is not suitable for testing the sailing capacity of yachts or boats. To utilize wind from all directions, a platform of wire netting should be placed in a situation like the top of the shearlegs on Garden Island. The top of a building, cliff or rugged mountain would be unsuitable, as walls and vertical surfaces merely create the aerial breakers which it is the wish of the experimenter to avoid.

It is well at this point to have a distinct understanding that soaring is quite different from kite-flying and gliding. In gliding as practiced by Lilienthal and others, a free apparatus descends from an eminence and its fall is more or less retarded by the air on which it slides. In kite-flying, a weight attached to the earth is raised and supported by the wind sliding under it. In soaring, the mechanism is unattached to the earth, and maintains its elevation by using as a motor the vortex that its peculiar shape generates. Most people would at once say the last statement involves perpetual motion, and therefore is not worth considering; a few will see that a ball retaining its position in front of a nozzle against gravity and the downward thrust of a high-pressure jet

Digitized by Google

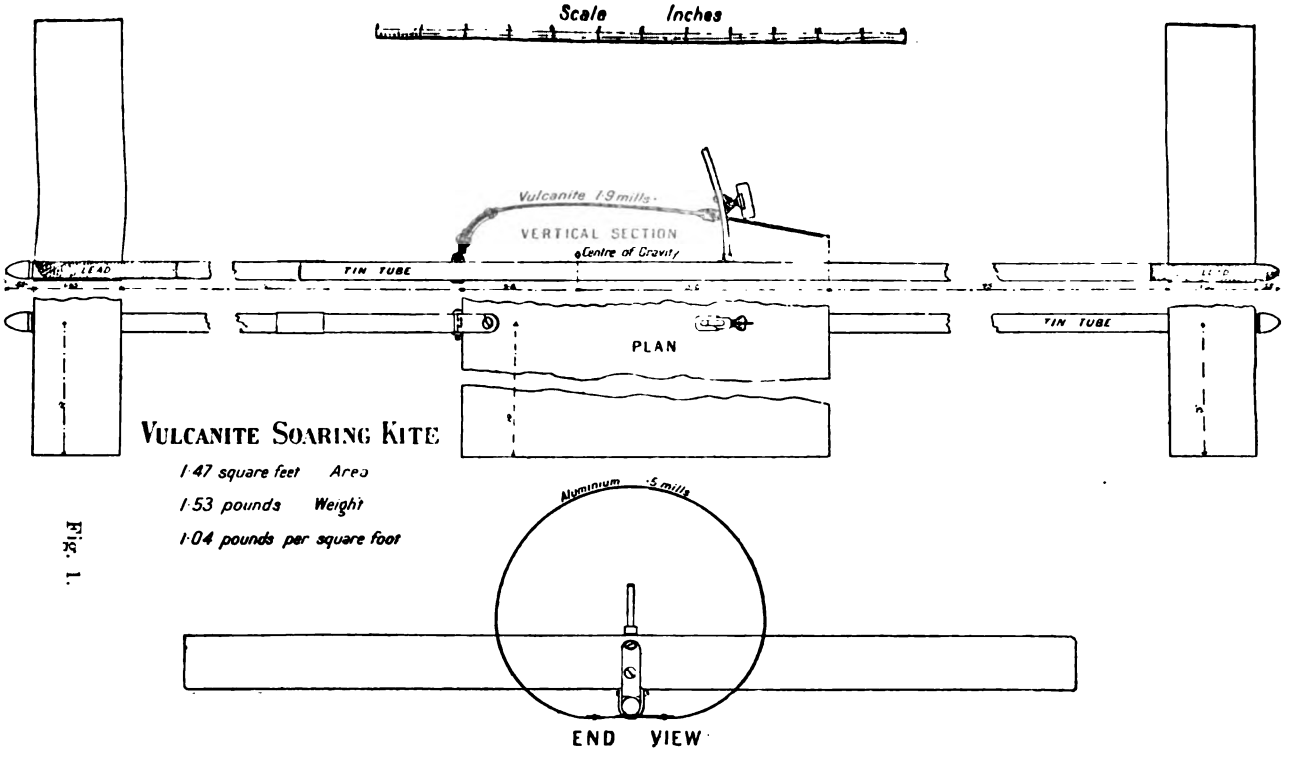
of water is a close analogy to the soaring vortex. The water clearly makes the ball weigh less than nothing. There is little doubt that the weight of a ball dancing on a fountain is greater than when it is at rest.

The makers of soaring models will find great difficulty in persuading them to remain tolerably stable in a fore and aft direction. The trouble will be greatly reduced if they avail themselves of the experience of a tight-rope walker with his balancing pole. The acrobat makes his pole as long and stiff as possible, and puts as much weight on the ends of it as he conveniently can, he then has no further difficulty with his athwartships stability. It is the inertia of the weighted ends that takes the wobble out of his body. Likewise the weighted ends of the fore and aft tubular rod in Figs. 1 and 2 check the erratic motion of the vulcanite propeller.

When you consider the conformation of a soaring bird, it will be noticed that a large part of the under surface is not adapted for the formation of the soaring vortex. The tips of the rigid wings and tail are obviously of such a nature that they will not readily allow the bird to rise or fall suddenly when the soaring parts of the wings are struck by a gust from underneath or above. These surfaces are represented in Figs. 1 and 2 by the horizontal projection of the surfaces of the two cylindrical cells at the ends of the tubular rod. The vertical projection of the two cells represents the vertical surface of a cellular kite or the dihedral angle of some soaring birds.

The parts of a soaring bird's wings next to the body are represented in Figs. 1 and 2 by the bent sheet of vulcanite. This is the propeller, and it makes sufficient thrust to overcome its own head resistance and that of the rod and two end cells. No attempt has yet been made to ring the changes on the numberless curves that probably soar; the essential points seem to be that the front part of the propeller shall be bent to about the quadrant of a circle, the extreme after part plane, and the intermediate portion hyperbolic. Rigidity of construction is all-important. Springy

Digitized by Google



VULCANITE SOARING KITE

1·47 square feet Area

1·53 pounds Weight

1·04 pounds per square foot

Fig. 1.

Digitized by Google

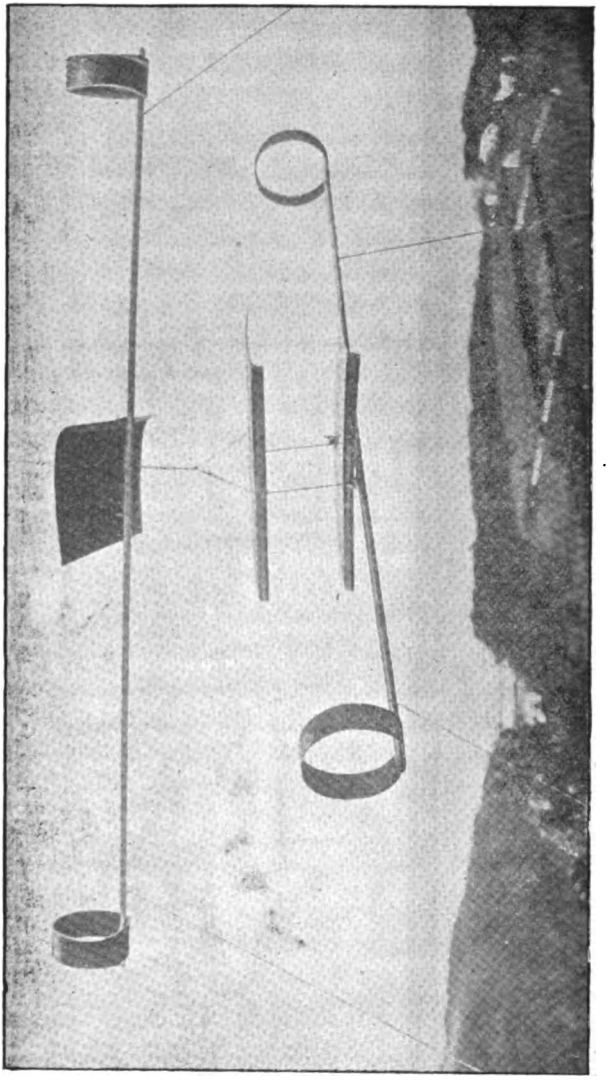


Fig. 2.

Digitized by Google

and vibratory surfaces are not conducive to steady soaring; their practical effect is to increase the head resistance. No curved surfaces made of muslin have yet soared; the nest for the vortex must be hard and smooth.

The tubular rod and two end cells form really a cellular kite, and their head resistances are reduced to the utmost. In Fig. 1 the total area exposed is 1·27 square inches without making any deduction for rounded edges. In addition to this there is the drift of the two strings which in practice will be dispensed with. The horizontal projected area of the cylindrical cells is 46·8 square inches, that of the propeller 165 square inches, total 211·8 square inches; the total weight 1·53 lbs. gives a weight of 1·04 lbs. per square foot.

The force of the wind required to make any show at all with the model depicted must be at least fourteen miles per hour; light north-east and west winds have been a sore trial to the writer's patience, south-east and east being the only winds from which any results can be expected in the locality where the experiments are being carried on.

The centre of gravity in Fig. 1 is 2·6 inches abaft the leading edge of the propeller and 3·725 inches forward of the middle of the tubular rod. The string is attached to the centre of gravity. The vulcanite propeller is fastened in such a manner that the angle it makes with the rod and cells can be varied from $+1°$ to $-14\frac{1}{2}°$; the best results in light winds have been obtained with about $3\frac{1}{2}°$ negative angle. There is no way of finding accurately at what angle the wind strikes the cells; the rod appears to be horizontal.

A light string is tied to the after end to prevent the kite rushing over the horizontal cord; this string is slackened out till the kite is near the level of the top of the poles and in a horizontal position facing the wind; it then soars to windward, sometimes over but more frequently under the cord. Sometimes the kite can be steadied near the zenith by means of the tail string.

Digitized by Google

The question arises as to what is the use of trying to make a large soaring machine, if under ordinary circumstances one may wait weeks for a few hours' trial with small models. Irrespective of the pleasure to be derived from attempting to unravel nature's secrets, there is the prospect that an apparatus fitted with soaring curves may be raised by thrust in calm weather with greater facility than the ordinary screw-driven aeroplane; and that although the air is calm near the earth's surface, a few hundred feet elevation would bring the machine into disturbed air where the soaring curves would develop their full power and the machine could then proceed without steam.

The late gales (May 5) enabled me to find out that the pounds per square foot suitable for a fourteen miles per hour wind did not give as good results in thirty-five miles; and served to show that there are three cases in which soaring is possible:

Case 1. When all the surfaces are shaped for soaring. This form of apparatus will be extremely difficult to steer.

Case 2. When the cellular kite part of the machine is inclined at a slight positive angle. This form is for use in the lightest winds in which soaring can be done.

Case 3. When the cellular kite as well as the propeller is at a negative angle. This is for very strong winds.

There is no reason why the propeller should not act if the axis of the vortex is not horizontal. Possibly concentric ring propellers may be found to give steady and uniform results with little weight. The kite shown in the Fig. 1 has been greatly improved by increasing the rigidity of the tubular rod; it is now ·55 inches external diameter, and all the ballast is put inside the ends. There is 12·75 inches of ·5 inch round lead in the forward end and 6·75 inches inside the tail. This brings the weight up to 1·9 lbs. per square foot. When loaded to 1·87 lbs. per square foot with a wind of sixteen or seventeen miles per hour, the propeller set at a negative angle of 6·3°, and centre of gravity 3 inches abaft the leading edge of the propeller, it has frequently soared to the end of its tether.

Digitized by Google

The soaring kite with the double propeller rolls very sharply; this is thought to be due to the centre of gravity being too low. The rod is now clamped to the steel wires joining the two parts of the propeller, in such a way that it can be adjusted vertically.

As it seems impossible to arrange for the members to see these particular experiments, it is thought that an accurate drawing of the model is amply sufficient to enable others to reproduce and extend the elementary observations here recorded.

The principle points that require investigating, are :—

1. How much the after edge of the propeller can be cut away without impairing its efficiency?

2. What is the diameter of vortex that is best for general use?

3. How many propellers can be advantageously superposed ?

4. The proper relation between the propeller area and the kite area.

5. The shortest rod that will keep the longitudinal equilibrium stable.

6. What is the supporting power of the propeller when used for gliding, as compared with that of the gliding machines now used ?

7. Can the vortex be produced by a motor in calm air so as to be more economical than the thrust of a screw?

8. To make an instrument to show simultaneously what pressure there is at every part of the concave and convex surfaces of the propeller.

These alone form a large volume of work for one pair of hands to endeavour to accomplish, and it appears regrettable that Australians should leave to Americans and others the tardy adoption of the views circulated by this Society.

A steam screw motor Figs. 3 and 4, which is intended to develop five or six horse power has taken up much time, but as yet it will not work in a reliable manner. It is of course quite a secondary consideration while the soaring kites are developing. The water

Digitized by Google

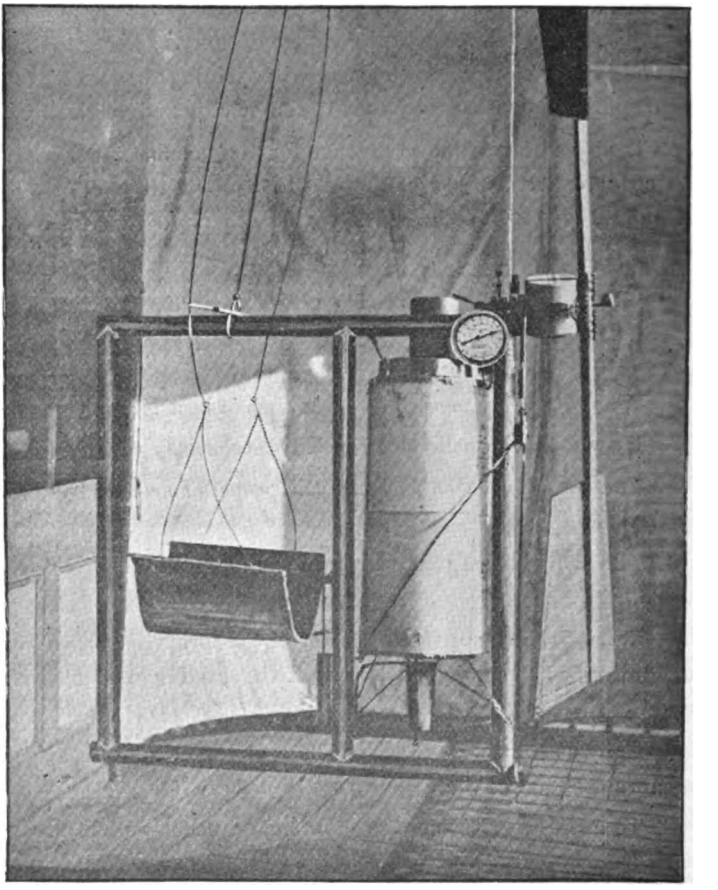


Fig. 3.

is contained in the square part of the tubular frame, and the kerosene in the centre upright part. The cylinders (2) are 4·25 inches diameter, the stroke is one inch, and they rotate with the screw. The shaft is clamped to the frame. The boiler is made of one hundred and twenty-four feet six inches of $\frac{1}{16}$ inch copper pipe, with 10·27 square feet outside heating surface; the capacity is 88·4 cubic inches. Weight of pipe is 8·37 lbs., coiled eight and a half inches outside diameter. The upper two-thirds

Digitized by Google

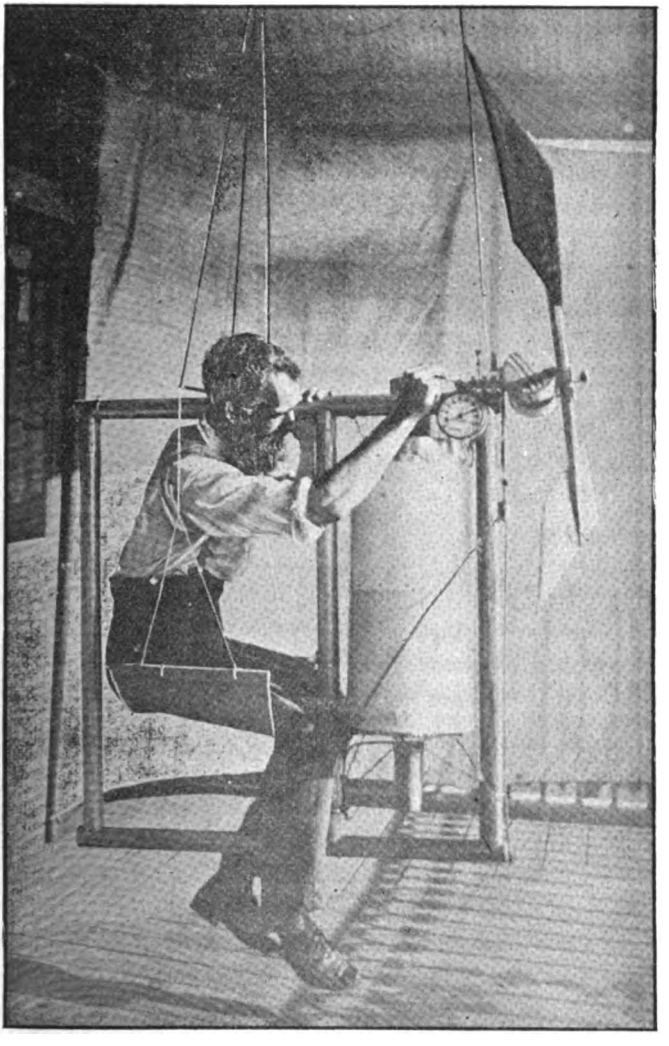


Fig. 4.

of the pipe branches into two parts joining again at the steam pipe. The fuel is vapourized in seven feet six inches of one-quarter inch copper pipe coiled inside the tin burner casing

Digitized by Google

shown under the boiler. The total weight of the motor exclusive of water and kerosene is 36·5 pounds.

The principle that long continued thought on any subject must tend to a clearer view of the detail connected therewith, has encouraged me to state some considerations as to the disposition of the supporting surfaces of flying machines that do not seem to have yet struck other experimenters.

It has been usual to make the lifting surface in one or more pieces rigidly connected to the weight to be lifted. In the machine for the engine, Figs. 3 and 4, it is intended to depart considerably from this practice by dividing the required surface into numerous small aeroplanes, all attached to the weight by one wire.

The aeroplane derives its lifting power either from moving air passing it when attached to the earth or from being moved horizontally through calm air; in either case there is no necessity for the aeroplanes to be connected to the weight by rigid booms and numerous stays, as the lift and drift can act only in tension and in one vertical plane. By dividing the surface into a number of small planes, any refinement of curve may be introduced with the certainty that the advantage accruing therefrom will be effectively used, and that the head resistance will be reduced to a minimum.

It will be obvious that forty aeroplanes of ten square feet area each can be constructed with much less material for spreading them horizontally than one plane of four hundred square feet area. In fact we are substituting arithmetical for geometrical progression in the weight of our surfaces and their head resistance, and lifting our machine pound by pound with foot by foot of added surface. We are also able to unite very large and therefore more efficient engines with the extraordinary lifting power known to exist in small and carefully curved aeroplanes. You will gather from these remarks that the proposed flying machine will be a rather tall structure, and that fact alone will make it extremely easy to work and certain in its action.

The most suitable time for experimenting will be when the wind velocity is slightly below that at which the machine is

Digitized by Google

designed to fly. The aeroplanes are sent aloft kite fashion, the anchor restraining the drift. Steam is then raised and the propeller started; if it is driven hard enough the machine rises over and picks up the anchor; if the power is insufficient no risks have been run and there are no damages to repair.

There is no special gear for causing the machine to ascend or descend; it is simply a matter of more or less steam. The turning to the right or left is done by pulling slightly on one or other of two strings attached to the forward corners of some of the lower aeroplanes. The weight is kept from spinning round by some small vertical surface to the rear of and in a line with the thrust of the propeller, so that it is immaterial whether the weight is deflected by the small vertical surface and pulls the aeroplanes after it, or the aeroplanes are made to shoot to one side by the strings and pull the weight after them. There will probably be an advantage in the motor working in air of less velocity than the higher current when going to windward.

It is not generally understood that when the motor has succeeded in thrusting sufficiently hard to run over and lift the anchor, the aeroplanes exert a steady lift on the motor, and that whether the wind blow high or low, or change its direction, the whole apparatus maintains a uniform velocity through the air as long as the engine maintains a uniform speed. Of course the machine will drift with the air currents, but this set has to be allowed for and a course shaped accordingly. The set of the air current would be unknown if the earth were invisible; in like manner that the set of an ocean current is not ascertainable when out of sight of land without the aid of astronomy.

If there is no wind at all, there is no means of getting this form of flying machine aloft except by making a more or less extended run along the ground. This run may be then made round a circular track. In the event of the motor stopping, the machine does not fall vertically as a parachute, but slides down gradually in any desired direction. These remarks refer to the screw-driven aeroplane machine, if soaring propellers are substituted for some or all of the aeroplanes, a new power is introduced that completely modifies all preconceived conditions.

Digitized by Google

AUSTRALIAN DIVISIONAL SYSTEMS.

By R. H. MATHEWS, L.S.

[*Read before the Royal Society of N. S. Wales, June 1, 1898.*]

IN the following pages it is proposed to give a brief account of all the intermarrying divisions of the aborigines throughout Australia, with which we are acquainted up to the present time. As no similar work has hitherto been attempted, it is hoped that an article of this character will be found of some value to others who may embark in the same line of investigation. The group and totemic divisions are strongly manifested in all the principal ceremonies of the Australian aborigines; hence it is of the utmost importance that any one studying the customs of these people should have a knowledge of their divisional systems.

Before proceeding to enumerate the different systems found throughout the continent, it will perhaps be interesting to give a short outline of the structure of aboriginal communities in general.

An Australian tribe has certain territorial limits, and is known by a general name, which is in most cases derived from the language spoken by its members, as is the names of the Wiradjuri, Kamilaroi, Koombanggary, etc. The area of a tribe's domain varies with the character of the district they inhabit, as well as with the numerical strength of the people. In the well-watered coastal districts of New South Wales, where fish and game are abundant, their hunting grounds would be comparatively small; whilst in the open plains of the interior, where game is not so plentiful and water is often scarce, the tract of country required to support a tribe would necessarily be more extensive.

Every tribe is made up of several sub-tribes, all speaking the same language, each of which occupies its own hunting grounds, which are defined by hills, water-courses, patches of scrub, or other remarkable natural features. Each of these sub-tribes has

Digitized by Google

a headman or chief, and these headmen collectively are the rulers of the whole tribe. The customary laws are administered by these headmen, who, in the exercise of their authority, are supported by all the initiated men of their respective divisions. When a number of these tribes are bound together by having the same divisional (or class) systems—speaking dialects of the same tongue, participating in identical or similar initiation ceremonies, and among whom intermarriage is more or less frequent—they form communities. Aggregates of these communities may be called nations.

The members of a tribe, and of course, also of its component sub-tribes, are divided into two exogamous intermarrying groups, bearing distinctive appellations, and having a more or less varied selection of totems attached to each. In some tribes these two groups are the only divisions observable—the individuals of one group intermarrying with those of the other—of which the Mattiri and Karraru groups at Port Lincoln, South Australia, may be taken as an example.

In other tribes the two groups are subdivided into smaller segments. For example, the Yuipera tribe at Mackay is composed of two primary groups, called Wootaroo and Youngaroo; the former is again divided into two sections, called Woongo and Coobaroo, and the latter into two, called Bunbia and Gurgila.

In other communities, of which some tribes in the Northern Territory may be taken as an example, the two primary groups are segregated into four sections each. Group A. is subdivided into Choolum, Jamerum, Chenum and Yacomary. Group B. is similarly divided into Chingalum, Bungarin, Chooralum and Palyarin.

There are other tribes, especially in some parts of West Australia, whose divisions appear to be of an abnormal type, but I shall be glad to receive further particulars before coming to any definite conclusions respecting them.

Besides the segregation of the community into the groups and sections to which I have referred, there is another partition of

Digitized by Google

the latter into lesser divisions, bearing the names of animals, or other natural objects, which from their analogy to the well known North American tribal divisions, have been called *totems*. It is evident therefore that an aboriginal native inherits a group and a sectional name, followed by that of his totem. For example, a man of the Kamilaroi tribe may belong to the group Kupathin, section Ippai, and totem Emu. In addition to these ancestral titles, each blackfellow has his own personal name, as Fleet-foot.

The individuals belonging to any group, section, or totem, do not collect into certain localities by themselves, separate from the rest, but are dispersed indiscriminately throughout the whole tribal territory—members of each section and totem being found in all the local divisions. It is possible for all the totems in the community to be represented in the same locality. This dispersion of the totems is due to the intermarriage of the individuals of which the groups and sections forming the social community are composed.

As the intermarriages of the groups, sections and totems will be fully explained later on, it is only necessary to say here that, in nearly all Australian tribes descent is reckoned through the mother only—the father being generally disregarded in determining the division to which the children belong. There are also strict totemic regulations of universal prevalence which prevent persons of the same totem from either marrying or having sexual intercourse with each other.

In dealing with this subject it will be preferable to take the divisions existing in each of the colonies separately, stating shortly who was the first to observe them, and then to give particulars of their structure and geographic range, from information collected by myself.

South Australian Divisions.

The Rev. C. W. Schürmann was the first to place on record the rules of marriage and descent in force among the aborigines of

Digitized by Google

South Australia. In a pamphlet which he published in 1840,[1] describing the customs of the Parnkalla and other native tribes inhabiting the Port Lincoln district, on the west of Spencer's Gulf, he says: "They are divided into two distinct classes, the Mattiri and Karraru people. . . If a husband be Mattiri, his wife must be Karraru, and *vice versâ*, the children taking invariably the appellation of that class to which their mother belongs." That is, if a Karraru man married a Mattiri woman, the sons and daughters would be Mattiri, the same as their mother. In a similar manner the children of a Karraru woman would be Karraru. Mr. C. Wilhelmi, in 1860[2] confirmed the divisional names and rules of descent given by Mr. Schürmann.

These rules of marriage and descent will be more apparent if arranged in tabular form, thus:—

Husband	Wife	Offspring
Mattiri	Karraru	Karraru
Karraru	Mattiri	Mattiri

In 1874 the Government of South Australia issued circulars asking for certain particulars respecting the customs of the aborigines, and such circulars were sent to all persons likely to be acquainted with the subject throughout the colony. In response to these notices, a large amount of valuable information was obtained, and was published by the Government Printer, Adelaide, in 1879, under the title of "Folklore, Manners, Customs, and Languages of the South Australian Aborigines." This book was edited by the Rev. George Taplin, who had taken an active interest in the movement from its inception. In the following pages references will frequently be made to the work mentioned.

Mr. James Bryant mentions two divisions as obtaining amongst the tribes about the Gawler Ranges, who adjoined the Port Lincoln people on the north. He spells the names of the divisions as

[1] Aboriginal Tribes of Port Lincoln, S.A. (R. Thomas & Co., Adelaide). This work is republished in "Native Tribes of South Australia," (1879), pp. 207 – 252.

[2] Trans. Roy. Soc., Victoria, (1860) Vol. v., p. 178.

Digitized by Google

Muthury and Cariero, and states that they intermarried with each other.[1]

Still farther inland, round the head of Spencer's Gulf, and down the eastern side of it as far as Crystal Brook, as well as in the Flinders Ranges, which extend from there to the east of Lake Torrens, Mr. Noble reports the existence of the same two divisions which he calls Muttay and Arriee.[2] Both Mr. Bryant and Mr. Noble call these divisions "clans,"—which is by the way quite as suitable a term as "classes," although neither of these names are very appropriate.

Mr. Samuel Gason, in describing the customs of the Dieyerie tribes at Lake Eyre, states that they were organised into intermarrying divisions, bearing the names of animals.[3] In 1882, Mr. A. W. Howitt, from information supplied by the Rev. H. Vogelsang, a missionary among the tribes referred to, reported that their divisions were Mattiri and Karraru, being the same names as those stated by the Rev. C. W. Schürmann at Port Lincoln. Dr. E. C. Stirling in 1896,[4] and Professor W. B. Spencer in 1897,[5] mentioned these divisions in the same district.

It will be seen that I have traced the two divisions, Mattiri and Karraru, through a wide extent of territory, reaching from Port Lincoln, viâ Port Augusta and Farina, to somewhere about Oodnadatta, a distance of over seven hundred miles. From the latter place northerly to the neighbourhood of the James Ranges the tribes are divided into four sections; and thence to the Gulf of Carpentaria they are divided into eight sections, the particulars of whose organisation I shall now endeavour to explain.

In 1875, Mr. Christopher Giles,[6] who was a station master at Charlotte Waters telegraph station, reported that the tribes in that neighbourhood, who spoke the Arrinda language, were divided

1 Folklore, Manners, &c. of S. A. Aborigines, p. 103. 2 *Ibid.*, p. 64.
3 The Dieyerie Tribe of Australian Aborigines, (1874), p. 13.
4 Horn Exped. Central Australia, Part iv., p. 46.
5 The Engwurra Ceremony—Proc. Roy. Soc. Vic., N.S., x., 18.
6 Folklore, Manners, &c. of S. A. Aborigines, pp. 82–91.

Digitized by Google

into four classes, called Parroola, Panungka, Booltara and Koomurra. He gave the rules of intermarriage established in relation to these four divisions, with the names to which the offspring belonged, which may be briefly summarised as follows:

Husband	Wife	Offspring
Paroola	Panungka	Koomurra
Panungka	Parroola	Booltara
Booltara	Koomurra	Panungka
Koomurra	Booltara	Parroola

In 1878, Mr. J. D. Woods[1] confirmed the observations of Mr. C. Giles in regard to the divisions of the tribes from the Peake to Charlotte Waters and Alice Springs, his spelling of the four names being as follows: Parula, Pooninga, Pultara and Coomara. He says the children of either sex always take their mother's family name. Mr. E. M. Curr mentions the same names in 1886.[2] In the same year they were referred to by Mr. F. E. H. W. Krichauff,[3] and in 1887 Mr. D. Lindsay also mentions having observed them.[4] Mr. W. H. Willshire reported these four classes at Alice Springs in 1891,[5] and again in 1895.[6]

The Rev. Louis Schulze, a missionary at Hermannsburgh, on the Finke River, discovered that each of the four classes which had been reported by previous writers, had a fellow or complementary class, if I may so term it, attached to it, thus making four pairs of classes, or eight divisions in all. The names of the additional classes he found to be Pungata, Mbutjana, Knurraia and Ngala.[7] Mr. Schulze also observed that a man had the privilege of choosing his wife from either of two prescribed divisions. A Bultara man, for example, could marry either a Koomara or Mbutjana woman.[8]

1 Trans. Philos. Soc., S. Australia, II., 85-86.
2 Australian Race, I., 417.
3 Proc. Roy. Geog. Soc. Aust., S. A. Branch, II., 33.
4 *Ibid.*, II., 3rd Session, p. 4.
5 The Aborigines of Central Australia, (Adelaide, 1891) p. 13.
6 Journ. Anthrop. Inst., XXIV., 183.
7 In 1897, Professor Spencer and Mr. Gillen confirmed the existence of the four additional divisions.—Proc. Roy. Soc., Victoria, X., N.S., 19.
8 Trans. Roy. Soc. S. Australia, XIV., 223 - 227.

Digitized by Google

I was much interested in the paper communicated by Mr. Schulze, and during 1895 I was enabled to make independent enquiries through Mr. Jackson, a friend who went out to the mica and ruby fields in the Hart's ranges, and the gold mines about Arltunga, or Paddy's Waterhole, as it is commonly called. From information then obtained, I was enabled to tabulate the divisions as under, showing two intermarrying groups, A and B :—

	Husband	Wife	Children
Group A.	Bultara	Koomara	Panungka or Knurraia
	Pungata	Mbutjana	Knurraia or Panungka
	Parulla	Panungka	Koomara or Mbutjana
	Ngala	Knurraia	Mbutjana or Koomara
Group B.	Koomara	Bultara	Parulla or Ngala
	Mbutjana	Pungata	Ngala or Parulla
	Panungka	Parulla	Bultara or Pungata
	Knurraia	Ngala	Pungata or Bultara

My correspondent confirms Mr. Schulze's statement regarding the intermarriage of the men of a pair of complementary sections with the women of another pair. Thus, Bultara can marry a woman from either the Koomara or Mbutjana sections, and Pungata can marry into either of the same sections that Bultara can. If Bultara marry a Koomara woman, the children will be Panungka, but if he select an Mbutjana wife, the children will be Knurraia. It appears, therefore, that the children of each of these men may be either Panungka or Knurraia, which is regulated by the section to which the mother belongs. Marriage and descent in the other pairs of sections will follow the same rules, *mutatis mutandis*, as examplified in the table.

It will be seen by the above table that my arrangement of the divisional names differs from that of Mr. Schulze. He also states that the children have paternal descent, but Mr. Jackson represents that they belong to their mother's group, as shown in the table,

Digitized by Google

and this is supported by Mr. Woods' statement already quoted. As there is a difference of opinion in regard to the line of descent among the Alice Springs tribes, I intend making further enquiries and will also endeavour to obtain comprehensive particulars respecting the totems. For the present, therefore, a list of totems already collected will be omitted.

My correspondent afterwards made his way northwards, and before leaving the Hart's Ranges I gave him such particulars of the divisions of the Warramonga tribes as I could obtain from Mr. A. M. Giles' statements published by Mr. A. W. Howitt,[1] and asked him, if he had the opportunity, to make certain further enquiries which I indicated. He met some of these blacks and gathered particulars from which I am able to tabulate eight divisions in the following order, illustrating the rules of marriage and descent:

	Husband	Wife	Sons	Daughters
Group A.	Kabatjee	Nakamarra	Ungary	Namatjillee
	Opalla	Namatjillee	Ampatjona	Tampatjona
	Apungata	Tampatjona	Aponunga	Naponunga
	Tungulli	Naponunga	Akamarra	Nakamarra
Group B.	Akamarra	Kabatjeen	Opalla	Narulla
	Ungary	Narulla	Apungata	Napungata
	Ampatjona	Napungata	Tungulli	Nungulli
	Aponunga	Nungulli	Kabatjee	Kabatjeen

The foregoing table shows that the community is segregated into two groups, A and B, one of which intermarries with the other; and each of these is again subdivided into four sections, the names of which are given. The sons of the women of group A marry the daughters of the women of group B, and *vice versa*, therefore the women of one group are the mothers of the men of the other.

Each group has perpetual succession through the women—the daughters belonging to the same group as their mothers, but to a

[1] Journ. Anthrop. Inst., XIII., 44.

Digitized by Google

different section of it. The women of group A pass successively through each of the four sections in as many generations. For example, taking the women of group A in the table, we find that Nakamarra is the mother of Namatjillee; Namatjillee of Tampatjona; Tampatjona of Naponunga; and Naponunga is the mother of Nakamarra, the same sectional name with which we started, and this order of succession is repeated *ad infinitum*.

The men of any given section likewise reappear in the fifth generation, but in a different manner to their sisters. We have seen in the last paragraph that the women of a group never pass out of it, but perpetually alternate from one section to another. The men, however, fluctuate from one group to the other in each generation. For example, Kabatjee, of group A in the table has a son Ungary who belongs to group B; Ungary has a son Apungata of group A; Apungata has a son Aponunga of group B; and Aponunga has a son Kabatjee, which brings us back to the starting point in group A. In four generations the men pass through two sections of each group.

The son of the brother marries the daughter of the sister, and conversely, the son of the sister marries the daughter of the brother. This can easily be shown by preparing a short pedigree of any given individual. Let us take a man of the Opalla section as an example:

Opalla marries Namatjillee

Son	Daughter	Daughter	
Ampatjona		Tampajona	
Ampatjona marries Napungata		Apungata marries Tampatjona	
Son	Daughter	Son	Daughter
Tungulli	Nungulli	Apanunga	Naponunga

By this table it is seen that Opalla marries Namatjillee, the offspring being Ampatjona and Tampatjona. Ampatjona marries Napungata, and has a son and daughter Tungulli and Nungulli. Ampatjona's sister Tampatjona marries Apungata and has a son

Digitized by Google

and a daughter Aponunga and Naponunga. Tungulli the son of Ampatjona marries Naponunga, the daughter of Tampatjona his father's sister. Apanunga the son of Tampatjona marries Nungulli, the daughter of Ampatjona his mother's brother. The relationship of brother and sister here referred to must of course be understood as tribal only, and not of the full blood.

Mr. S. N. Innes, having read my paper on the Kamilaroi class system,[1] took a lively interest in the subject and commenced studying it. He wrote me that he was acquainted with a number of tribes having very interesting divisions, and stated his willingness to assist me if I gave him the points on which to make enquiries. This I immediately did, and made such suggestions as I thought might be of value. After a lot of correspondence, and much thrashing out, I am now enabled to prepare the following table, showing the divisions of the tribes occuping a considerable tract of country in the Northern Territory, stretching from near the Gulf of Carpentaria westerly across the overland telegraph line; and there is reason to believe that a similar organisation extends onwards into West Australia.

	Husband	Wife	Sons	Daughters
Group A.	Choolum	Ningulum	Palyarin	Palyarinya
	Jamerum	Palyarinya	Chooralum	Nooralum
	Cheenum	Nooralum	Bungarin	Bungarinya
	Yacomary	Bungarinya	Chingulum	Ningulum
Group B.	Chingulum	Noolum	Yacomary	Yacomarin
	Bungareen	Yacomarin	Cheenum	Neenum
	Chooralum	Neenum	Jamerum	Neomarum
	Palyarin	Neomarum	Choolum	Noolum

The community is divided into two intermarrying groups, A and B, the men of one group marrying the women of the other, or the sons of group A marrying the sisters of the men of their own generation in group B, and *vice versa*, subject to certain rules which

[1] The Kamilaroi Class System of Australian Aborigines—Proc. Roy. Geog. Soc. Aust. (Q.), x., 18 - 34.

Digitized by Google

are apparent in the table. The women never change out of the group to which they belong, but pass successively through each of the four sections of which it is composed. Taking the women of group A as an example, it is shown that Ningulum is the mother of Palyarinya, Palyarinya of Nooralum, Nooralum of Bungarinya, and Bungarinya of Ningulum, and this series is continually repeated, each section name reappearing in the fifth generation. Succession is counted through the females—the women of one group producing the men of the other.

New South Wales Divisions.

The Wiradjuri and Kamilaroi communities are divided into the four undermentioned sections, the names of the women in each section being different from those of the men. For example, in some families all the sons are Murri, and all the daughters Matha; in others they are Kubbi and Kubbitha; in others Ippai and Ippatha; and again in others they are Kumbo and Butha. These names were first reported by the Rev. Wm. Ridley in 1853 as occurring among the Kamilaroi tribes on the Namoi and other rivers.[1] Since then I have reported the same divisional names among the Darkinung[2] tribe of the Wollombi district, and among the Moorawarrie of the Culgoa and adjacent rivers. I have also observed four divisions with the same nomenclature among the Wailwan, Uollaroi, Wallaroi, Pickumbul, and Ukumbul tribes.

The intermarriage of the sections, and names of the offspring can be more clearly understood by means of a table:

Husband	Wife	Offspring
Murri	Kumbo	Ippai
Kubbi	Ippai	Kumbo
Kumbo	Murri	Kubbi
Ippai	Kubbi	Murri

From particulars supplied by Mr. Chas. G. N. Lockhart, the Rev. L. Fison, in 1872, states that among the Darling River tribe

[1] Studies in Ancient History, Second Series (1896), by J. F. McLennan, p. 289; also, Kamilaroi etc., (1866), p. 38.

[2] Journ. Roy. Soc. N. S. Wales, xxxi., 170, 171.

Digitized by Google

at Wentworth, a Kilpara man must always marry a Mookwara woman, and a Mookwara man a Kilpara woman.[1] Speaking of the same people in 1875, the Rev. R. W. Holden[2] reports the same divisional names and rules of marriage as those given by Mr. Fison, but neither of these gentlemen mentioned the divisional names of the offspring. In 1878, Mr. R. B. Smyth, in referring to these divisions says, on the authority of Mr. J. Bulmer, that the children take their caste from their mother.[3] For example, if the mother be Mookwara the children will be Mookwara; if the mother be Kilpara, the children will also belong to that division. This appears to be the first report showing the line of descent in the tribe referred to.

In May 1883, Mr. F. Bonney, who resided fifteen years near the Darling, mentions the divisions Muckwarra and Kilparra as obtaining on the Darling River above and below Wilcannia. He also mentions their prevalence among the natives of the Barrier Ranges, which includes Silverton and adjacent stations.[4]

In 1884-85 I was surveying in the Silverton and Broken Hill district, and made a tour from there to Tibooburra, and thence to the Darling viâ the Paroo river. Among the tribes throughout that immense tract of country I found the two divisions, Muckwarra and Keelparra, with groups of totems attached to each.

In 1885, Mr. A. L. P. Cameron, who lived some years between the Darling and the Lachlan Rivers reported that these two divisional names extended up the Darling from Wentworth at least as far as Menindie. He was also the first to observe that Mukwarra was equivalent to the pair of sections Murri and Kubbi of the Kamilaroi, and that Kilparra was the equivalent of the Ippai and Kumbo sections.[5]

In 1883, Mr. E. Palmer described the divisions of what he called the Kombinegherry tribe on the Bellinger River,[6] consist-

1 Trans. Roy. Soc Victoria, x., 161.
2 Folklore, Manners, &c. of S. A. Aborigines, p. 17.
3 Aborigines of Victoria, i., 86.
4 Journ. Anthrop. Inst., xiii., 129. 5 *Ibid.*, xiv., 351. 6 *Ibid.*, xiii., 304.

Digitized by Google

ing of the four sections Kurbo, Wombo, Marro, and Wirro. Since then I discovered the same divisions, with some modifications of sound and spelling, among the tribes of the Clarence, Kempsey, Manning, Hastings and Hunter Rivers, with their numerous affluents. I also found similar divisions in the New England tribes, but two of the female sectional names were entirely different. I have elsewhere given the sectional names and list of totems, of all the tribes referred to in this paragraph with their rules of marriage and descent.[1] I was moreover the first to establish the equivalence of the sections to those of the Kamilaroi and Wiradjuri communities.[2]

Queensland Divisions.

The Rev. Wm. Ridley gave the names of the four divisions of the Kogai tribe, on the Balonne, Maranoa and Coogoon Rivers, with the laws of marriage and descent as follows :—[3]

Husband.	Wife	Sons	Daughters
Wūngo	Unburrigun	Urgilla	Urgillagun
Obūr	Urgillagun	Unburri	Unburrigun
Unburri	Woongogun	Obūr	Obūrrūgun
Urgilla	Obūrrūgun	Wūngo	Wungogun

Mr. Ridley was also the first to draw attention to the equivalence of the sectional names in different tribes. For example, he showed that Wūngo of the Maranoa tribe was equivalent to Murri of the Kamilaroi; Obūr to Kubbi, Urgilla to Ippai, and Unburri to Kumbó.[4] It may be as well to explain that when a certain section in one tribe holds the same place in the system as a section in another tribe, such sections are said to correspond to each other, or in other words, to be equivalent, as in the above example.[5]

When Mr. R. B. Smyth was compiling his work on the aborigines, published in 1878, one of his correspondents, Mr. George Bridgman, Superintendent of Aboriginal Stations, near Mackay, who had seen Mr. Ridley's classification, reported that

[1] Journ. Roy. Soc., N. S. Wales, xxxi., 168–171. [2] *Ibid.*, xxxi., 169, 170.
[3] Kamilaroi and other Australian Languages, (1866) p. 38. [4] *Ibid.*, p. 38.
[5] Proc. Roy. Geog. Soc. Aust. (Q.), x., 31.

Digitized by Google

the Yuipera and adjoining tribes at Mackay were divided into two primary classes, each of which was subdivided into two others. This will be better understood in tabular form :—[1]

Primary Division	Husband	Wife	Offspring
Wootaroo	Woongo	Bunbia	Gurgila
	Coobaroo	Gurgila	Bunbia
Youngaroo	Bunbia[2]	Woongo	Coobaroo
	Gurgila	Coobaroo	Woongo

The above four names, although differing somewhat in spelling from those reported by Mr. Ridley, are manifestly the same.

Mr. Bridgman was the first to observe that the tribe, although divided into four sections, actually consisted of two groups, Wootaroo and Youngaroo ; and that the children belong to their mother's primary division, but to the other section of it. He further states :—"An intelligent native now at Mackay, who has been living with the Kamilaroi people, says the Kamilaroi system is the same as that here." This was subsequently found to be correct by Mr. Cyrus E. Doyle, one of Mr. A. W. Howitt's correspondents, who reported the primary divisions of the Kamilaroi as being Dilbi and Kupathin.[3] He had no doubt been informed of the two groups of the Mackay tribe, published five years before. The Rev. L. Fison, in 1880, and Mr. E. M. Curr in 1886, also refer to Mr. Bridgman's researches.

In 1883 a paper by Mr. Edward Palmer[4] was read before the Anthropological Institute, London, containing the results of his personal researches, in which he dealt, *inter alia*, with the divisions of the tribes on the Flinders, Cloncurry, Mitchell, Kennedy and other rivers in Northern Queensland. He showed that the natives about Hughenden and the heads of the Flinders and Cloncurry Rivers, and extending easterly from Tower Hill Creek

[1] Aborigines of Victoria, (1878), I., 90, 91.

[2] This word is written Bembia in Smyth's book, but it is evidently a misreading of the MS., for we find that Mr. Bridgman spells the word Bunbia in an article he contributed to Mr. Curr's work on the "Australian Race," Vol. III., p. 45.

[3] Journ. Anthrop. Inst., (1883) XIII., 335. [4] *Ibid.*, XIII., 302.

Digitized by Google

towards the Belyando River, were divided into four sections called Woonco, Coobaroo, Bunbury and Kurgielah,[1] which is practically the same nomenclature as the tribes at Mackay and Maranoa River. The intermarriages of the sections, and the names of the offspring, were also identical.

In 1886 Mr. E. M. Curr published the names of the same four divisions as obtaining among the Kowanburra, Wokkelburra, and other tribes on the Belyando and Suttor Rivers, Elgin Downs, Bowen Downs, and the sources of the Alice. The particulars were supplied to Mr. Curr by Mr. James Muirhead, a resident of that district. This gentleman appears to have been the first to draw attention to the native custom of each section being restricted to certain kinds of food. He stated that the Bunbury section is confined to opossum, kangaroo, dog, honey of small bee. Woongo is allotted emu, bandicoot, black duck, black snake, brown snake. Obur has carpet snakes, honey of stinging bee, etc. Kurgilla has porcupine, plain turkey, etc. He also observed that Woongo and Obur formed a primary division called Wootheroo, whilst the other two sections were Mallera.[2] The primary division Mallera is the equivalent of Youngaroo of the Mackay tribes.

Some of Mr. Curr's correspondents reported the same four sections among the tribes of the Nogoa and other head waters of the Mackenzie River[3]; and at Logan Downs, Peak Downs, etc., where the primary divisions were called Youngaroo and Wootheroo,[4] being identical with those at Mackay. Other correspondents of the same author discovered that the four divisions referred to also obtain at the Cape River.[5] At Halifax Bay—at Hinchinbrook Island, and on the mainland adjacent—identical sectional names were reported to Mr. Curr,[6] and published by him in his valuable work.

[1] Each of these names has a feminine equivalent: Wooncoan, Coobarooan, Bunburyan, and Kurgielan.

[2] The Australian Race, (1886) III., 26, 27. [3] *Ibid.*, III., 91. [4] *Ibid.*, III., 65.

[5] *Ibid.*, II., 468. Mr. Curr mentions the names Utheroo (Ootaroo), and Multhuroo (Mallera), as occurring on the Cape River.

[6] *Ibid.*, II., 418, 425 and 427.

Digitized by Google

The Rev. Wm. Ridley, in his "Journal of a Missionary Tour among the Aborigines in 1855,"[1] stated that the family names at Moreton Bay were Bandūr, Bundar, Barang and Derwain, with the corresponding female names Bandūran, Bundaran, Barangan, and Derwaingan. He reported that the Warwick and Canning Downs blacks had the same family names as at Moreton Bay, and also that these names prevailed from the latter place to Wide Bay.[2]

In 1865 Mr. G. S. Lang said: "The Moreton Bay blacks are divided into four classes, and all the children take after the class of their mother."[3] The Rev. E. Fuller, a missionary for some years at Fraser's Island, north of Wide Bay, says: "The children are supposed to belong to the mother's tribe."[4]

In 1883 Mr. E. Palmer stated that he found the divisions mentioned by Mr. Ridley extending northerly from Wide Bay to near Rockhampton, except that Balcoin was used instead of Bandūr.[5] He also reported them as existing among the tribes in the Bunya Bunya Mountains. The last statement is confirmed by the Rev. J. Mathew, one of Mr. Curr's correspondents. Mr. Mathew says: "The names of the children depended directly on the mother's name."[6]

Mr. Palmer, from information supplied to him by Mr. Jocelyn Brooke, Sub-Inspector of Police, gives a diagram showing the four names in a rectangular position, and states that "the child always takes its name from that opposite to its father's name."[7] This does not necessarily lead to the inference that descent is through the father, though it may bear this construction.

In 1888 Mr. A. W. Howitt, from particulars furnished to him by Mr. Palmer's informant Mr. Brooke, arrived at the conclusion that "descent was in the male line."[8] In 1894, partly from Mr.

[1] This article was also published in Dr. Lang's "Queensland," (1861), p 436

[2] Kamilaroi and other Australian Languages, (1875), p. 163.

[3] Aborigines of Australia, p. 10.

[4] *Queenslander*, Sept. 7, 1872.

[5] Journ. Anthrop. Inst., XIII., 304, 305.

[6] Australian Race, III., 162, 163.

[7] Journ. Anthrop. Inst., XIII., 305. [8] *Ibid.*, XVIII., 49, 50.

Digitized by Google

Palmer's statement above referred to, and partly owing to Mr. Howitt's conclusions, I assumed that these tribes had paternal descent.[1] On making further enquiries of some natives of Jondaryan run, who belong to this organisation, the following arrangement of the divisions was arrived at—the spelling being in accord with the pronounciation of my native informants.

Husband	Wife	Sons.	Daughters
Djerwine	Bandjooran	Barrang	Barrangan
Bunda	Barrangan	Bandjoor	Bandjooran
Bandjoor	Djerwinegan	Bunda	Bundaran
Barrang	Bundaran	Djerwine	Djerwinegan

When travelling among the tribes on the head waters of the Clarence, Richmond, Dumaresq and Condamine rivers, I found the rules of marriage and descent somewhat different to those obtaining farther north, particulars of which are given in the following table :—

Husband	Wife	Offspring
Terrawine	Barrang	Banjoor
Bunda	Banjoor	Barrang
Barrang	Terrawine	Bunda
Banjoor	Bunda	Terrawine

Terrawine and Bunda are the equivalents of Ippai-Kumbo, and Barrang-Banjoor of Murri-Kubbi.

In the article published by Mr. Palmer in 1883 he gave the sectional divisions of the Mycoolon and Myappe tribes on the Saxby and Cloncurry Rivers, with the laws of marriage and descent which he tabulated as follows :—[2]

Husband	Wife	Offspring
Marringo	Goothamungo	Bathingo and Munjingo
Yowingo	Munjingo	Jimmalingo and Goothamungo
Bathingo	Carburungo	Marringo and Ngaran-nghungo
Jimmalingo	Ngaran-nghungo	Yowingo and Carburungo

[1] Proc. Roy. Geog. Soc. Aust. (Q), x., 29.

[2] Journ. Anthrop. Inst., XIII., 302.

Digitized by Google

This table clearly shows that there is matriarchal descent, and Mr. Palmer reports that such is the case. Mr. A. W. Howitt, however, arranges Mr. Palmer's sectional names in a different order to that shown above, and endeavors to show that descent is through the father. He says "under the influence of agnatic descent, the girl is of the same class name as her mother's mother."[1] This is not correct, because in the Kamilaroi tribes, where descent is uterine, the daughter always takes the sectional name of her mother's mother.[2]

Mr. Palmer also reported the discovery of four other sectional names among the Koogobathy tribes on the Mitchell River and surrounding country. These divisions he arranged as follows, with the rules of marriage and descent:[3]

Husband	Wife	Offspring
Jury	Barry	Mungilly
Mungilly	Ararey	Jury
Ararey	Mungilly	Barry
Barry	Jury	Ararey

He stated that Jury was equivalent to Marringo, Mungilly to Yowingo, Ararey to Bathingo, and Barry to Jimmalingo. When I first read Mr. Palmer's paper—having confidence in his general accuracy in other cases—I assumed that descent among the Koogobathy was in the male line; and in a paper I wrote in 1894, it was stated that there were some tribes in the Gulf country who had agnatic descent.[4] Shortly afterwards I made enquiries through correspondents, who reported that the children belonged to the mother's group, the same as in the Mycoolon tribe. In a paper read before the Royal Society of Queensland in September 1897, I corrected the statement I had made in 1894.[5]

A blackfellow at Charters Towers, who had travelled with drovers to the Palmer river informed me that the descent of the

[1] Journ. Anthrop. Inst., XIII., 346.
[2] Proc. Roy. Geog. Soc. Aust. (Q.), X., 24.
[3] *Ibid.*, XIII., 304.
[4] *Ibid.*, X., 32.
[5] "Aboriginal Customs in North Queensland."—Proc. Roy. Soc. Queensland, XIII.

Digitized by Google

children is uterine, as exemplified in the following table. He spoke from memory of what the Palmer natives had told him, and I have not yet had an opportunity of checking his statement.

Husband	Wife	Offspring
Jury	Barry	Ararey
Mungilly	Ararey	Barry
Ararey	Mungilly	Jury
Barry	Jury	Mungilly

In 1897 Dr. Roth found that the same divisions which had been reported by previous writers on the Maranoa, at Mackay, and the other places referred to also obtained on the Hamilton, Georgina and neighbouring streams. Dr. Roth also confirmed the sectional names discovered by Mr. Palmer among the Mycoolon and Myappe tribes; and further, he ascertained the equivalence of the sections to those of the tribes about Hughenden and Boulia. For example he states that Bathingo corresponds to Coobaroo, Jimmalingo[1] to Woongo, Yowingo to Kurgielah, and Marringo to Bunbury. He also reports that the Mycoolon divisional names are found with some modifications, in the Kalkadoon and neighbouring tribes.[2]

West Australian Divisions.

Capt. Grey, now the octogenarian Sir George, when exploring in West Australia in 1837-39, observed that the natives were divided into certain great families; and that each family adopted some animal or vegetable as their *kobong* or totem. A man could not marry a woman of his own family name, and the children always took the family name of their mother. Sir George gives the names of these divisions as Ballaroke, Tdondarup, Ngotak, Nagarnook, Nogonyuk, Mongalung and Narrangar. From his table of genealogies I collect the following partial statement regarding the intermarriage of the sections:

1 In 1883 Mr. E. Palmer stated that Jimmalingo belonged to Wootharoo among the Leichhardt River tribes, which agrees with Mr. Roth's observations.—Journ. Anthrop. Inst., XIII., 303.

2 Ethnological Studies among the Australian Aborigines, (1897), p. 57.

Digitized by Google

Ballaroke marries Ngotak, and the children are Ngotak
Ballaroke „ Noganyuk, „ „ Noganyuk
Tdondarup „ Ballaroke, „ „ Ballaroke
Ngotak „ Ballaroke, Nagarnook and Noganyuk
Noganyuk „ Ngotak and Tdondarup.[1]

In an official report on the "Habits and Customs of the Aboriginal Inhabitants of West Australia," printed at Perth in 1871, p. 21, Bishop Salvado gives the names of six classes prevalent in the tribes at the Catholic Mission Station at New Norcia, in the Victoria district, eighty-two miles northerly from Perth. The names of the classes which each one of the others may marry, and also the classes into which they may not marry, are stated, but unfortunately the classes to which the children belong are not given. The information supplied by Salvado may be tabulated thus:—

Class	Could Marry	Could not Marry
Tirarop	Palarop, Jiragiock N-ocognok	Tirarop, Mondorop Tondorop
N-ocognok	Palarop, Tondorop Tirarop, Mondorop	N-ocognok Jiragiock
Palarop	Tondorop, Mondorop N-ocognok, Tirarop	Palarop Jiragiok
Tondorop	Palarop, N-ocognok Jiragiok, Mondorop	Tondorop Tirarop
Mondorop	Jiragiock, Tondorop N-ocognok, Palarop	Mondorop Tirarop
Jiragiok	Tirarop, Mondorop Tondorop	Palarop, N-ocognok Jiragiok

The information supplied by Sir George Grey, and by Bishop Salvado, is very meagre and unsatisfactory. I trust that if this article of mine should be read by any gentlemen residing in either of the districts referred to, that they will endeavour to gather

[1] Two Exped. N.W. and W. Australia, (1841) Vol. II., pp. 225, and 228.

Digitized by Google

further details regarding the divisional names and totems, with the rules of marriage and descent established in relation to them.

When Sir John Forrest visited Nichol Bay on the north-west coast, in 1878, he found that the aborigines were divided into four families, with rules of marriage and descent which he tabulated in the following manner :—

Husband	Wife	Children
Paljarie	Kimera	Banigher
Boorunggnoo	Banigher	Kimera
Kimera	Paljarie	Boorunggnoo
Banigher	Boorunggnoo	Paljarie

The grand-child in the male line is of the same family as his grand-father; and in the female line, of the same family as her grand-mother.[1]

In 1880, the Rev. L. Fison published these class names, which he had obtained from a correspondent, as Paliali, Paronga, Kimera and Banaka.[2] A correspondent furnished Mr. E. M. Curr with the same divisions in 1886, which he reported as Palyeery, Boorungo, Kymurra, and Panaka.[3] The resemblance of these names to those of the divisions at Alice Springs, 1000 miles to the eastward, is remarkable.

Equivalence of Divisions.

It is highly important to show how the groups and sections of a tribe in one district correspond to those of other tribes in different parts of the country. From some natives whom Mr. Jackson met about Oodnadatta, Macumba and Charlotte Waters, he ascertained that the group Mattiri of the Arrabunna tribe was equivalent to the pair of sections, Bultara and Parulla of the Arrinda tribe; and the group Karraru to the sections Panungka and Koomara. I subsequently checked this statement by referring to Mr. Kempe of Peake Station, who gave me the same answer.

1 Journ. Anthrop. Inst., IX., 356, 357. Austr. Assoc. Adv. Sci., II., 653, 654.

2 Kamilaroi and Kurnai, p. 36.

3 The Australian Race, I., 298.

Digitized by Google

The equivalence of the Alice Springs and Warramonga tribes is as follows:—Bultara corresponds to Kabatjee; Pungata to Apungata; Parulla to Tungulli; Ngala to Opalla; Koomara to Akamarra; Mbutjana to Ampatjona; Panungka to Aponunga; Knurraia to Ungary. It is evident therefore that the group Mattiri is equivalent to the four sections of group A of the Alice Springs and Warramonga tribes respectively; and that Karraru corresponds to group B of each of these communities.

In June, 1887, Mr. David Lindsay stated that the Warramunga tribe occupied the country lying between Tennant's Creek and Powell's Creek, N.T., and for a considerable distance on each side of the Overland Telegraph line. He was also the first to report that they had an unusually large number of divisions regulating the intersexual relations.[1]

[1] Proc. Roy. Geog. Soc. Aust., S.A. Branch, Vol. II., 3rd Session, p. 10.

Digitized by Google

ARTESIAN WATER IN NEW SOUTH WALES.

By J. W. BOULTBEE.

[*Read before the Royal Society of N. S. Wales, June 1, 1898.*]

THAT a work is now in progress, perhaps the most important ever undertaken to aid the development of the arid lands of this Colony, no one will I think deny, the possibilities of which, however I fear, are at present far from adequately recognised and considered. The superiority of this means of water supply to pastoral lands, over the precarious and inferior supplies afforded by water conservation in excavations and by well sinking, is beyond dispute. The further possibility of the irrigation of limited areas in the neighbourhood of population centres, and of small close settlement is attracting attention and criticism. The first essay in artesian boring made in 1879, by Mr. David Brown of Kallara Station, in the Western Division—was in the neighbourhood of one of the numerous mound springs which dot this area—which resulted in flowing artesian water, did not then attract the general attention it deserved, and it was not until some years later that the Government of the colony purchased some boring plants, ineffective compared with those of the later type, and with them had some success, obtaining flowing wells upon the Bourke to Wanaaring Road. It was, however, reserved to a Canadian driller, and some spirited pastoralists, to really exploit the industry by the introduction of the Canadian Pole Rig, and the contract system, which was followed by the Government, after a far seeing Crown tenant, Mr. W. Davis of Kerribree Station, near Bourke, had demonstrated its superiority over old existent methods. The work both public and private has progressed rapidly, but there is still an enormous proportion of the 60,000 square miles of artesian water-bearing country untouched and unexplored by the drill.

The question of the utilization of artesian water for irrigation and cultivation did not enter in any way into the calculations of

Digitized by Google

the Government, or of those Crown tenants who essayed to find it, the main and only object being the provision of water for stock. The results in this direction have far exceeded anticipations, and miles of ditches, carrying the flowing water through enormous paddocks have been made.

The other aspect of the question, namely the closer settlement in small holdings in the neighbourhood of bores, near centres of population, has been dealt with by the Government in the experimental farms etc. at the Native Dog and Pera Bores, and is rapidly passing beyond the range of experiment. In the initiation of an experiment, such as this, much consideration had to be given to the many questions arising in connection with it. In the first place there existed a widespread and ill-defined fear, now rapidly passing away, that artesian water was unsuitable for irrigation, and that there would be no market for produce: and that according to the experience of a pastoral population used to large areas of land, the possibility of doing anything with so small an area as twenty acres was very remote. The Department had to avail itself of the experience obtained in other countries, and to enquire and decide what area the class of people it expected to obtain as settlers could cope with single handed.

The evidence furnished by the wonderful development at Fresno in the San Joacquin Valley, California, is most important, and it largely guided the Department. In 1871 five hundred emigrants from the East settled there and secured some 5,000 acres of land, which was divided into small vineyards for the cultivation of the raisin grape: the progress made has been phenomenal, and Fresno stands as one of the most prosperous settlements in California, and a striking example of what intense culture upon small areas means. The land originally cost 2·50 dollars per acre. The population within twenty years reached 100,000 souls, and Fresno city is to day a well laid out town, with all modern improvements, of some 25,000 inhabitants, surrounded by an area of 20,000 acres of vineyards. The condition of this land at the time of the inception of the settlement is described as follows:—"The entire area

Digitized by Google

of which would be worthless except for occasional croppings of wheat and sparse feeding of cattle, without the system of irrigation in vogue."

The cultivation area is now stated to have a capital value of 30,000,000 dollars, and had it been sold twenty years ago for 1,000,000 dollars that would have been considered a high price. When once the vines commenced to bear in 1873, the return began to come in, and has increased yearly; in that year 6,000 boxes of raisins (20 lbs. each) were shipped; in 1883 the yield was 140,000 boxes or 2,800,000 lbs.; in 1890, 900,000 boxes or 18,000,000 lbs. The land values run from fifty to one hundred dollars per acre, that is land unimproved with water, improved and under ditch, from one hundred to three hundred dollars per acre. I quote two returns shewing the total areas and subdivisions and the yield per acre for this district. The first gives the numbers of holdings of from two to one hundred acres respectively, and the areas above the latter quantity. The second return shows the results per acre and the areas of the holdings, and as it will be seen, the best returns are from the smaller holdings.

No. of holdings.	Agregate Acreage.	Average acreage per holding.	Remarks.
473	4,087	8·46	From 2 to 10 acres
570	9,068	15·90	,, 10 ,, 20 ,,
207	5,552	26·82	,, 20 ,, 30 ,,
156	5,755	36·90	,, 30 ,, 40 ,,
43	2,072	48·18	,, 40 ,, 50 ,,
44	2,571	58·43	,, 50 ,, 60 ,,
22	1,429	64·95	,, 60 ,, 70 ,,
55	4,279	77·8	,, 70 ,, 80 ,,
6	510	85	,, 80 ,, 90 ,,
10	985	98·5	,, 90 ,, 100 ,,

In addition to the 1,586 holdings given above, there are 77 embracing from 107 acres up to 800 acres, making a total in these larger holdings of 15,407 acres, or an average of over 200 acres each. The total area in the smaller holdings reaches 49,325 acres, and gives an average holding of a little over thirty-one acres each.

Digitized by Google

The following table illustrates the yield :—

Total acreage of holding.	Vines—acres.	Fruit—acres.	Yield raisins, tons.	Per acre in grapes, tons.	Per acre in fruit, value, dollars.	Total value, dollars.	Number of acres.	Yield per acre, dollars.
8	8	...	...	137	...	1100	8	137·50
14	9	3	...	244	133	2600	14	185·90
20	12	2½	16	133	228	2167	14½	155·00
20	20	...	20	...	...	3000	20	150·00
20	7	2	18	259	50	1963	9	218·00
20	15	3	...	247	60	3705	18	205·00
30	...	30	...	...	83	2500	30	83·33
40	11	20	14	127	98	3197	31	103·12
40	30	...	45	145	...	5400	30	184·00
40	15	11	33	151	100	4430	21	163·33
80	70	...	70	...	100	7000	70	100·00
80	20	1	12	60	150	1350	21	65·00
118	118	...	118	118	...	13962	118	118·37

Other returns could be quoted showing much larger values and returns also, than the forgoing statements indicate, but the above are sufficiently moderate to be taken as a reliable basis for calculating the returns from nearly all fruit land in California, except that devoted to Citrus culture. The average net returns per acre of wine raisins, prunes, and deciduous fruits, generally when they are in a matured state, will range from eighty to one hundred dollars per acre. The average net returns for matured orange and lemon orchards will not be less than three hundred and fifty dollars per acre, when all conditions are fair. The statements of fifteen residents in San Bernardino County, California, for example, sets the ordinary value of such land at three hundred to fifteen hundred dollars per acre. The majority of them placed the selling value of such orchards at from eight hundred to one thousand dollars per acre.

The evidence also furnished by another prosperous settlement in California gives a further striking example of the progress and possibilities of the small holding—I refer to Riverside, the crack fruit ranch of Southern California. This settlement was commenced in 1870 by people from the Eastern States, under the leadership of the late Judge North, and attention was at once

Digitized by Google

given to the cultivation of the orange. Regarding it Colonel Hinton states :—"At that time the site of Riverside was occupied by an Indian villiage. Without artificial conservation and distribution of water, Riverside, like other prosperous settlements of San Bernardino County, would have had no real value for farm purposes. It would have taken eight hundred acres of its area to support a ranchman or hunter, and twenty-five to poorly feed one broad horned steer. About 6000 people now live with the greatest comfort, even luxuriously, upon 6000 acres of land. Within the range of cultivated land in America there will be found no settlement more closely worked or subjected to more intensive farming, returning a larger result for labour, skill and enterprise, than this cultivated area," 3000 acres of which are under oranges, the trees varying in age from one to fifteen years. As at Fresno the yield shows steady annual increase. In 1880 1,480 car loads of oranges and lemons were forwarded to market as the product of the 3000 acres referred to. Taken at a value of 800 dollars per car load, which is the official value given, the shipment gave a return of 1,184,000 dollars, and a net return of 395 dollars per acre. Since 1880, additions, referred to later on, through the inception of the "Gage" system of artesian wells, have been made to the cultivated area, which upon Riverside proper is now some 12,000 acres, which supports a population of 8,000 souls.

Besides the Citrus fruits the raisin grapes, the Muscat of Alexandria and the Gordo Blanco are largely cultivated, and the return given for 1891 for this product alone amounted to 700,000 dollars, while the annual average value of fruit of all descriptions, shipped from Riverside, is stated to be 2,200,000 dollars. This gives a return of 300 dollars per acre, presuming that 8,000 acres only are at present revenue producing. Colonel Hinton thinks that the original cost of this land did not exceed 100 dollars per acre, or 1,200,000 dollars in all. He estimates the total cost of the works for the original settlement at Riverside at 80 dollars per acre, or a total of say 500,000 dollars; for the other works, viz., pipes, pumps, canals and artesian wells, the total cost will be

Digitized by Google

about 1,100,000 dollars, making in all 1,600,000 dollars, or a fraction over, for the whole 12,000 acres embraced in the settlement, of 100 dollars per acre. The maintenance of the system appears to be but a comparatively small item. It may be seen by these statements, which are rather above than below the mark, as to the cost of land and works, that two years' production at Riverside would return a profit of fifteen per cent., at least on the average totality of outlay. Of course the present value of land to the later purchasers and occupants give an entirely different balance sheet. Even with these high figures a large return is secured, as for example, a purchase was made in 1890 of a ten acre orange orchard, all of which was in bearing: the cost of the land and trees to the purchaser was 1000 dollars per acre: the crops sold divided into two grades of oranges, one for 1750 dollars and the other for 1250 dollars, making a return of 300 dollars per acre. Under this percentage of returns the purchasers would in less than four years receive 2,000 dollars more than their original outlay. During the past year the returns from Citrus trees at Riverside ranged from 100 dollars to 261·80 dollars per acre. These figures cover the net, not the gross profits.

As further illustrating the value of, and the preference for the small holding in America, the same authority instances a sale recently held of 8,000 acres by an irrigation company, at which the land brought an average of 66 dollars per acre; 2,000 acres of which were sold in ten acre blocks, the balance being in twenty, forty, fifty, sixty, seventy and eighty acre blocks.

Besides Riverside there are other settlements wholly dependent for their water supply upon artesian wells, the most important of which is the Lake View Colony in Riverside County. The original value of these dry lands did not exceed ten dollars per acre; many thousands of acres have been sold with water rights attached for 100 dollars per acre, and are still rising in value. This colony is served by a group of wells, yielding one and a half cubic feet per second (say 800,000 gallons per twenty-four hours), the estimated capital value of which is £10,000 per cubic foot per second, it

Digitized by Google

being estimated that the duty of this volume of water is 250 acres. The State Engineer, Mr. Wm. Ham Hall, who is at the present time, I believe, reporting upon the question of water conservation generally, for the Government of the Cape of Good Hope, in 1891 pointed out what a marked effect upon land values the institution of the Gage system of artesian wells had at Riverside. There was a large area of land above the existing canal, to which there was but small expectation of bringing water. This land is described as being worth ten dollars per acre, while that under irrigation at Riverside was worth 250 dollars per acre. The construction of the Gage artesian wells and canal brought the water to these dry lands, and at once increased their value from ten dollars to 200 and 500 dollars per acre.

In the Dakotas, Kansas, Colorado, Texas, as well as other States in the arid region of America, irrigation from artesian sources has been largely and successfully carried out, and the areas irrigated by the wells insure to the farmer a certain return for his labour in the worst season. Professor R. T. Hill in his report on the Occurrence of Artesian and other Underground Water in Texas, Eastern New Mexico and Indian Territory, west of the 97th meridian, published in 1892 by the U.S. Agricultural Department in part iii. of the Final Report of Artesian and Underflow Investigation, says of the artesian waters of the Black and Grand Prairies, the greatest artesian belt of Texas:—"In no portion of the country has there been a grander development of artesian wells than in the past five years in the Grand and Black Prairie regions of Texas. At numerous places throughout its extent magnificent flows of water have been secured, and what ten years ago was in many places a poorly watered district, now abounds in magnificent artesian wells, which supply water to cities and farms in quantity large enough to make many new industries possible, besides furnishing water to irrigate many thousands of acres. The wells vary in depth from fifty to nearly 2000 feet, with every intervening depth. They also vary in volume or flow from less than a gallon a minute to a thousand, and in pressure from

Digitized by Google

nothing to maximum. The purity of this artesian supply for domestic purposes and its healthfulness gave Fort Worth an enviable superiority which her rival cities were not slow to imitate, and as a result of her success nearly every city and village in the grand and Black Prairie Region and in fact throughout the State, made artesian experiments. A few of these were put down in unfavourable locations and were failures, but hundreds more were successful, and to-day most of the cities of the State, which before this artesian epoch were without good water, are supplied with abundance. . . The industrial uses to which these waters are at present put are many. At Waco hundreds of sewing machines in clothing factories, electric motors, wood-working machinery and other small industries, are run by the pressure of wells without wasting the water, by the use of small and powerful Californian wheels. When the high cost of fuel in Texas is considered, this use of artesian water becomes a most important factor. The greatest use of this water at present is the fact that it brings to hitherto poorly watered farming and grazing lands an abundant supply of water for domestic and stock purposes, making small farms of 100 acres or less possible, where until recently subdivisions of large bodies of land or ranches were impossible. . . . The value of these wells for irrigation has been demonstrated by the modest farmers of the Paluxy Valley, who by their own humble methods, and without previous knowledge of the subject, are now quadrupling the yield of cotton and grain. A farmer at Paluxy stated that his ten acres of cotton, yielding nearly two bales of five hundred pounds each to the acre was far more profitable and easily worked than one hundred acres which he had until recently cultivated in Alabama.

"The largest and most prosperous city in Texas, San Antonio, is built upon and about an irrigation enterprise, which has most profitably and successfully utilized their underground waters for nearly three hundred years, affording occupation for all the mission settlements in the past, supporting hundreds of gardens at present and destined to be of great value in the future."

Digitized by Google

"Every drop of water from these springs and wells can be utilized for irrigation, and when people of the region appreciate the fact that each gallon of water has a specific value in agriculture as has a pound of coal in industrial enterprise, not one drop of this water will be allowed to escape unutilized, and the agricultural wealth will be enormously increased."

There are more than one thousand flowing wells in Texas, nearly all of them being found west of the 97th degree of west longitude. Several hundreds have been bored during the year 1891. Their vast capability and adaptability for making secure an agriculture always rendered uncertain under high temperature, even when the rainfall if properly distributed is ample for industrial uses, appears to have become a matter of general understanding.

He further adds that in the development of such wells their use for irrigation was not dreamed of originally, but now they are being widely utilized. Riverside, before referred to, derives a portion of its water supply from artesian wells, which as I have stated are known as the Gage system. There are 12,000 acres under fruit served by fifty-five artesian wells, all grouped within an area of seven hundred acres, from which the water is taken in flumes or cement ditches to the land irrigated. There is also in the Upper San Gabriel Valley, a similar system known as the Whittier, which comprises fourteen wells; the works consist of eleven miles of cement conduit and 6,200 feet of fluming on trestles. The Alamosa Town Well is the source of supply for the thirty miles of ditches within its corporate limits. In Utah the artesian wells in the Salt Lake Valley were first used for irrigation eight years ago, since when the area of cultivation has increased from twenty-five to thirty-five per cent. There are now over 2,000 flowing wells in Utah. Within three years, and largely during the past year, over 3,700 flowing wells have been sunk in the San Louis Valley or basin, within an artesian area of 8,000 square miles. Comparing these statistics, relating to one artesian basin alone, with the statistics of our own Colony, where we have at present slightly over 120 flowing wells, both Government and

Digitized by Google

private, upon an artesian area of 62,000 square miles, it will be readily realized what a large field for development there is. The climatic conditions existing in this Colony and America are somewhat similar, the advantage if any, being with us. The whole of the country lying between the Rocky Mountains and the Sierra Nevada, and to some extent to the west of the Rocky Mountains embracing Southern California, Arizona, Texas and New Mexico, may be described as the arid lands of the United States. The temperature varies exceeding, that is to say from frost to 120° Fah. The climate is extremely dry. The rainfall in the dry belt of Southern California which embraces Riverside, Los Angeles, and the Kern Valley, varies from six to ten inches per annum. The area of this latter valley is eighteen by fourteen miles, and upon this area are sixty flowing wells, (utilized almost entirely for the irrigation of lucerne for stock feeding), which yield the handsome supply of 61,000,000 gallons per diem. In Arizona, Texas and New Mexico, the heat is more intense. Take for instance the Mojave Desert, the rainfall of which does not exceed six inches per annum, where wheat has been harvested, irrigated with artesian water, which took a prize against the competition of all Southern California,—the soil is described as a shifting sand growing in its natural state nothing but cactus, mesquite, and sage brush. The general character of the soil, except upon the Mesas or tablelands, is exceedingly poor, so poor that we have nothing so desert or arid in our Colony, and nowhere except perhaps in the Northern Territory of South Australia can a parallel be found to it.

If such a revolution in the condition of any land can be effected in the course of a few years, as has been done in America, one naturally pauses to think if there is any reason why the same results cannot be obtained in our western lands, where we have a soil of unbounded fertility, free from the alkali so prevalent in American soils, only requiring the beneficent aid of the water now lying hidden beneath the surface. The illustration of the problems, namely the possibility of close settlement, and the profitable

Digitized by Google

occupation of small areas upon land hitherto devoted to stock raising, and the employment of a nomadic and restless population, practically unacquainted with the steady, patient daily labour so necessary for the success of this class of industry, is now to be seen at Pera. The prejudice or fear as to the unsuitability of artesian water for irrigation is passing away, as will be seen from the following communication from Mr. Licensed Surveyor Mullen, Bourke, which indicates a distinct advance all along the line :—"I have just returned to Bourke after a trip of eight weeks through my district. I feel I must draw your attention to the fact that the Pera Experimental Farm has been the means of giving a great start to irrigation works on large and small scales throughout the Bourke district. I now have more irrigation farms to design and lay out within one hundred miles from Bourke than I can cope with this year, unless I give my whole attention to that business alone, and that I cannot do, as my hands are fairly full of Government work, which must be first attended to. About ten weeks ago I was engaged at Weilmoringle, adding to their present irrigation area of forty acres ; all this was under a very heavy wheat crop when I was there at work, and for two years running they have taken over one hundred tons each year off this small area. Their water supply is a bore of one and three-quarter million gallons per diem. The scheme was designed and levelled by me some three years ago. It is now intended to increase the area to one hundred acres, and I am engaged upon the plans for that scheme. They have carried their bore water for miles north, east, south, and west, in drains, to water their sheep in many different paddocks.

"At Kerribree I have instructions from the lessees to lay out forty miles of drains and an irrigation farm, and I hope to be able to tackle it this year. Nearly every station, and where they have the means, many small holders, practically recognise the value of home grown fodder in times of drought, and it is a pleasing relief to the eye to see the green patches on the banks of all the rivers in the districts of Bourke and Brewarrina, and nearly every

Digitized by Google

station has its irrigated vegetable garden. It is only within the last four years that crops have been irrigated with bore water.

"I must congratulate you on the success of the Pera Bore Farm. I consider that it is one of the wisest conceptions of the Department, and I hope to see the day when all our artesian water producing area will become much more closely settled through the means of irrigation, for without doubt the soil and climate are eminently fitted for the purpose, when bore or river water is judiciously applied to it, for I notice that the more the land is cultivated the less water it requires, and that the greatest mistake an irrigationist can make is too much flooding."

The question of markets is one that has not been adequately studied, and recently when giving evidence before the Public Works Committee, I stated that the local market in Bourke is far larger than is generally supposed, and I furnished a list of one firm's consumption in a year of products that can be grown at Pera, totalling the sum of £33,065. In regard to the production of fodder for stock, I stated that I do not think this aspect of the question has received the consideration it merits at the hands of pastoralists. Californian and Mexican stock raisers have recognised that with the irrigation of lucerne they can increase the carrying capacity of their ranches by thirty per cent. Here if they can only grow reserves of fodder against times of drought, the losses which so often occur could be mitigated and reduced. The Chowchilla Canal, Fresno County, California, thirty miles in length, is used solely for the irrigation of natural grasses. The area of irrigated lucerne in America is very large, and is stated to carry up to twenty sheep per acre, if cut and fed to them; eight and ten tons per acre is a common yield.

There is so far no sign of any alkaline deposit in the soil at Pera, nor should there be at any bore, provided the drainage is sufficient and an adequate state of tilth is kept up.

In regard to the actual and practical work of boring much has been done; much geological information has been obtained

Digitized by Google

also. The survey of the catchment area in Queensland, and the definition of the bibulous Blythesdale braystones, have done much to encourage the work and remove the impressions that existed as to a speedy diminution of the supply.

It was found that the basal or intake beds of the artesian system outcropping at various points had an area of about 1,000 miles long by forty miles wide, instead of two hundred miles long by one-eighth of a mile wide as previously supposed, and the opinion was expressed that the diminution, or rather cessation, of the flow could only result from such a drought as would mean the destruction of the land fauna of this part of Australia, including the genus homo. Taking up the survey on our border, where Mr. Jack, the Queensland Government Geologist, left it, our own Government Geologist, Mr. Pittman, has by his investigation and by the discovery of fossils from the Coonamble, Moree and other bores, demonstrated the existence of large supplies of artesian water in formations other than Cretaceous. He has by the direct evidence obtained, established a fact which had hitherto been a matter of conjectural opinion expressed upon imperfect evidence, namely that artesian water occurred in large volume in the Trias-Jura formations, and he adds that he would "even go so far as to suggest that the porous strata of the Trias-Jura formation may constitute the chief storage beds of the artesian water supply of Australia." This discovery practically adds an area of 22,000 square miles to the basin as hitherto recognised, and is perhaps the most important development yet experienced. In the actual work of boring the following figures give some idea of the steady progress made upon the Government works. Two of the bores, one completed and the other in progress, have been bores of exceptional difficulty and depth, that at Dolgelly, Moree District, being 4,086 feet, the supply being over a million gallons per diem. Upon reaching a depth of 2,600 feet, by the carelessness of a workman the casing was allowed to slip in the clamps, the fall telescoped the casing, and damaged both it and the hole, and it was only after nine months fishing that the damaged casing was

Digitized by Google

got clear and boring resumed. The work done was a monument of patience and skill. The other bore,-that at Bancanya, Broken Hill district, is still in progress at a depth of 3,600 feet. It required five strings of casing to be used before the immense bodies of drift met with all the way down to the 1,300 feet level was successfully pierced. Since that depth the bore has been continued at one diameter, viz., four inches, the smallest at that depth, 3,660 feet, ever attempted.

The following return indicates our yearly progress:—

Bores completed previous to June 1894...		26
„ June 1894 to June 1895		12
„ June 1895 to June 1896		10
„ June 1896 to June 1897		11
„ June 1897 to date ...		7
Total completed to date		66

Total depth bored previous to June 1894	...	34,678 feet
„ „ June 1894 to June 1895	...	22,516 „
„ „ June 1895 to June 1896	...	29,055 „
„ „ June 1896 to June 1897	...	20,104 „
„ „ June 1897 to present date...		31,234 „[1]
Total depth bored	...	137,587 „

Average cost, including casing and all charges previous to June 1894	38/7 per foot.
Ditto, June 1894 to June 1895	36/10 „
„ June 1895 to June 1896	37/3 „
„ June 1896 to June 1897	27/1 „
Flow from bores sunk previous to June 1894 (approximate)...	8,983,500 gals. per day.

[1] Includes bores in progress (10).

Digitized by Google

Flow from bores from June 1894 to June 1895	3,057,000	gals. per day.
„ June 1895 to June 1896 ...	9,967,000	„
„ June 1896 to June 1897 ...	4,597,000	„
„ June 1897 to date	4,069,000	„
Total output from Government Bores	30,674,500	„

Many improvements have been introduced in the tools and plants in use, the most notable being the Calyx Drill, which has a rotary motion, and with steel cutters chips an annular groove round a core, which is detached and removed after the manner of the diamond drill plant. The system which is being tested, would if successful, prove a far more acceptable and economical one than the percussive action of the existing tool, the Canadian pole rig. Rates for both boring and casing have been reduced fully twenty-five per cent. since the earlier bores were undertaken, and as the formations become known and more competition is introduced, the rates will no doubt fall further.

The introduction of the Artesian Wells Act 1897, by Mr. Sydney Smith, Secretary for Mines and Agriculture, will it is thought, open a new era for the pastoral tenants. Under the provisions of this Act an individual or a group of land holders can approach the Department, and upon dedicating a site for the bore, and together with other formalities undertaking to pay the charges levied under the Act, the Minister may construct a well and the necessary distributing channels. Upon completion, the charges which represent the direct benefit to be derived by each person, but which shall not exceed six per centum per annum on the cost of the works, are assessed by the Local Land Board, and such charges are a first charge upon the land. Twenty-two applications have already been received, representing groups of selectors owning up to 75,000 acres in the group. This will prove a great benefit, as the want of water on small holdings at critical

Digitized by Google

periods, has no doubt had the effect of simple annihilation for them.

The illustrations from the valuable American reports could be multiplied, and they all tend to show what the possibilities of the question are and how similar the conditions which existed twenty-eight years ago in America are to those now obtaining in New South Wales; also to point towards developments far beyond the conception of the present settlers upon our Western lands.

I am indebted to Colonel Hinton's valuable report upon the Artesian Well and Underflow Investigation 1893, Washington: to Professor Hill's report on the occurrence of Artesian and Underground Waters in Texas etc. 1892; also to departmental reports by the Government Geologists of New South Wales and Queensand, Mr. E. F. Pittman and Mr. Jack respectively.

Digitized by Google

On the "STRINGYBARK" TREES of N. S. WALES, Especially in regard to their ESSENTIAL OILS.

By R. T. Baker, F.L.S., Curator, and H. G. Smith, F.C.S., Technological Museum, Sydney.

[*Read before the Royal Society of N. S. Wales, July 6, 1898.*]

Part I.

Contents.

1. Introductory.
2. Botany of the Species.
3. Chemistry of the Oils.
4. Summary of Results.

1. Introductory.

This, the third paper read by us before this Society on the trees of the genus *Eucalyptus* and their essential oils, includes three species instead of one, as in previous papers, and sufficient botanical details are given to clearly establish the identity of the material employed in the research. The chemical results we regard as of some importance at the present time in view of the appearance of the new edition of the British Pharmacopœia just issued (1898).

2. Botany of the Species.

The trees to which the name "Stringybark" is applied in this Colony and which will be included in this, and Part II., of our Stringybark paper, are as follows:—*E. obliqua*, L'Her., *E. Baileyana*, F.v.M.; *E. macrorhyncha*, F.v.M.; *E. capitellata*, Sm.; *E. eugenioides*, Sieb.; *E. fastigata*, Deane and Maiden.

E. piperita, Link. might perhaps be placed in this list as well as *E. triantha*, Link, but our researches in connection with these latter species are not yet complete.

Of this list the best known "Stringybarks" are:—*E. macrorhyncha*, F.v.M., *E. capitellata*, Sm., and *E. eugenioides*, Sieb.;

Digitized by Google

the first is commonly called "Red," and the latter "White Stringybark," and we now propose the name of "Brown Stringybark" for *E. capitellata*. They have the widest range of the series and consequently any economics pertaining to them will be of the greatest importance to the Colony, and so we intend in this paper (Part I.) to confine ourselves to these three species, leaving the others to be dealt with subsequently. It is not proposed to give so full a description of each species as was done in our previous paper on "Grey Gum" *E. punctata*, DC., because in that instance the descriptions of the species had not been brought up to date; the above three "Stringybarks" have however only recently been examined by Messrs. Deane and Maiden.[1]

In regard to the sequence of species (a matter upon which we place the greatest importance) our researches have produced results which have inclined us to favour the classification of Baron von Mueller[2] rather than that of Bentham in his Flora Australiensis.

Our order of the following three species is the result of each of us working on quite independent lines of investigations, viz:—botanical and chemical. By agreement nothing was divulged till each line of investigation was completed, when it was found that both botanically and chemically the same affinities of species had been educed. Our researches however, lead us to suggest that there may be a missing species or species between *E. macrorhyncha* and *E. capitellata*, and also between the former species and its West Australian congeners, and we hope that our undescribed material will supply the "missing links."

Our researches have been carried out on material obtained from the following species:—

E. macrorhyncha, F.v.M.,

"Red Stringybark" of N. S. Wales, "Stringybark" of Victoria.

This species, founded by Baron von Mueller (1853) is figured and amply re-described in his Eucalyptographia Dec. I. (1879),

[1] Proc. Linn. Soc. N.S.W., Vol. xxi., p. 798 (1897).

[2] Second Census, Australian Plants.

Digitized by Google

whilst Messrs. Deane and Maiden (loc. cit.) have still further advanced our knowledge of this "Stringybark."

The timber is not so dense as that of either the "White" or "Brown Stringybark," and is inferior in durability to both, and the remarks appearing under it in the Botany of Rylstone,[1] were intended to apply to *E. eugenioides* and were placed there in error.

Habitat—As we now regard this *Eucalyptus* as probably the most important commercial tree of the whole genus, we give the following specific localities rather than state its general range. Orange district, Mudgee (and other places in the same district, viz:—Widdin Ranges, Mt. Corricudgee, Kelgoola, Rylstone, and Ilford), Marulan district, and Bungendore, where it is so plentiful within three miles of the railway station that a supply could be obtained for years to come.

E. capitellata, Sm., B. Fl. iii. p. 206. Eucalyptographia Dec. 3. "Brown Stringybark."

It is rarely called "Red Stringybark," and we should prefer to reserve this name for the previous species. In addition to the above references the descriptions of this species also have been quite recently amplified by Messrs. Deane and Maiden (loc. cit.) so that there is little more to be said concerning it except that our researches confirm its affinity with *E. eugenioides* as shown by a gradation of varietal forms mentioned by one of us in the Rylstone Botany.[2] In botanical sequence we place it between *E. macrorhyncha* and *E. eugenioides*.

The timber is very dense and no doubt very durable, but very little data has been published concerning it.

Habitat—Coast district and Dividing Range.

E. eugenioides, Sieb., B. Fl. iii. 208. Eucalyptographia, Dec. 10. "White Stringybark."

The remarks under previous species apply also to this one, as the two are very closely allied.

[1] Proc. Linn. Soc. N.S.W., Vol. xx., p. 447 (R. T. Baker).
[2] Proc. Linn. Soc. N.S.W., Vol. xi., 2nd Ser. p. 447.

Digitized by Google

The timber is the most durable and more highly prized than that of the two other "Stringybarks" of this paper. It is a most fissile wood and we have seen split posts and rails with a surface almost as smooth as if it had been planed. It is a tree that should be conserved, as besides its other qualities it would probably make an excellent wood blocking timber. The timber is very durable in the ground, and is in great request for posts in the Rylstone district.

Mr. H. J. Rumsey, writing from Barber's Creek, states:—"A few months ago I purchased an old three rail fence on Crown lands which was erected by a lessee twenty-five years ago, and have pulled it down and re-erected it on my own property. The rails which were all White Stringybark, *E. eugenioides*, are apparently as good and sound as the day they were erected, except for the ravages of fire in some places. The posts were White Stringybark, Grey Gum, *E. punctata*, and Snappy Gum, *E. micrantha*. The Stringybark have weathered below ground to the thickness of the sap about three quarters of an inch, on average quite sound above ground. The Grey Gum have mostly rotted below ground but are fairly sound above, while the Snappy Gum seem least affected of all. To all appearances the fence of White Stringybark supposed to be sixty years old still has many of the posts standing, but as they were split very thin originally they are not much good now."

Histological Notes.

The leaves of all three species, *E. macrorhyncha*, F.v.M., *E. capitellata*, Sm., *E. eugenioides*, Sieb., vary little in shape and outward appearance, and the histology of one is almost applicable to all three. The oil-glands are unequally distributed in number in each species, being most numerous in *E. eugenioides* and least numerous in *E. capitellata*. The stomata are also very numerous in each. The cells of the cuticle are very irregular in shape, the walls of which when seen in a surface view lack that regular polygonal structure as shown to exist in *E. punctata* in our previous paper.[1] The leaves are somewhat coriaceous, but least so in *E.*

[1] Roy. Soc. N. S. Wales, 1897.

Digitized by Google

eugenioides, and we were at first inclined to attribute this character to a much thickened cuticle, but microscopical transverse sections show that the epidermis has no such thickening, but resembles that of *E. punctata* (loc. cit.). The palisade layers, spongy tissue, vascular bundles, however, differ from those of *E. punctata* in that they contain a very much larger quantity of what appears to be chlorophyll. In the case of the "Red Stringybark," *(E. macrorhyncha)* it is principally myrticolorin. It is the presence of these bodies and not the thickened cuticularised external wall that gives the leaves the leathery opaque character.

3. Chemistry of the Oils.

Oil of E. macrorhyncha.

In the investigation of the oils obtained from the leaves of this species of Eucalyptus, the methods followed were those adopted in the research on the oil of *E. punctata*,[1] and although this investigation is not as complete as we could have desired, yet, we are able to decide that the same differences exist in the physical behaviour of the oils from *E. macrorhyncha*, as those found in the case of *E. punctata*. We had not the same facility for arriving at results from material obtained from individual trees or of trees of varying ages, as was previously done with *E. punctata*, since the Red Stringybark does not grow in the neighbourhood of Sydney, but we obtained material at different times of the year and from two localities, namely Ilford and Rylstone (N.S.W.). The leaves were distilled as soon as possible after removal from the trees, only two or three days elapsing between the dates of collection and distillation. The oils were reddish in colour in all instances.

No. 1. Oil from leaves collected at Ilford, distilled 25th March 1898.

The oil was light reddish-brown in colour, odour pleasant; yield 0·312 per cent. 100 lbs. of the leaves and branchlets yielding five ounces of oil; specific gravity as obtained 0·924 at 22° C. The

[1] Proc. Roy. Soc. N.S.W. 1897, 259.

Digitized by Google

oil was of too dark a colour to enable the rotation to be taken in a 200 mm. tube. On redistillation of 100 cc. a few drops only came over below 172·4° C., this portion contained some aldehydes and also some volatile acids, as the water that is always obtained in these redistillations was quite acid; the thermometer then rose slowly to 174·5° when the distillation proceeded, two per cent. having been obtained. The temperatures were read in whole degrees and were corrected to the nearest decimal. (See tabulated results).

First fraction 25%; sp. gr. = 0·8993, specific rotation = + 1·11°
Second „ 35%; „ = 0·903, „ „ = + 0·88°

Eucalyptol in crude oil—no satisfactory reaction with phosphoric acid. Eucalyptol in first fraction = 47·9%; second fraction = 53·0%

Equal volumes of the first and second fractions were added together and the eucalyptol found was 49·99 per cent. while the mean of the two fractions was 50·45 per cent.

No. 2. Oil from leaves collected at Rylstone, distilled 15th March, 1898.

This oil in colour and odour exactly resembled that from Ilford, yield 0·281 per cent., or 100 lbs. of leaves and branchlets gave four and a half ounces of oil; specific gravity as obtained = 0·927 at 22° C.; the oil was too dark to enable the rotation to be taken in a 200 mm. tube. On redistillation of 100 cc., the rate of distillation and the percentage results obtained between the several degrees of temperature 174·5° to 185·9° corresponded almost exactly with the results obtained from the Ilford sample, No. 1; and like the Ilford oil, contained but a small percentage of constituents boiling below 174·5°: the percentage of eucalyptol in the first fraction of both oils was but slightly less than that obtained from the second fractions; the oils obtained between the temperatures 174·5° and 185·9° were taken as one fraction; the specific gravity of which was 0·9023 at 23°; it showed no rotation in a 200 mm. tube. The eucalyptol present was found to be 51·4 per cent., while that of a first fraction of another distillation

Digitized by Google

gave 48·2 per cent. The determination of the eucalyptol in the crude oil was found to be as unsatisfactory as in the case of the crude oil from Ilford. The fraction distilling between 185·9° and 193·2° equalled 8 per cent., and had a specific rotation +1·54° and a specific gravity 0·911 at 18°, it contained a small quantity of an ester like the fraction obtained from the oil from Ilford. The portion requiring a higher temperature than 193·2° for distillation equalled 31 per cent. and contained about the same amount of eudesmol in this portion as was found to be present in the corresponding portion of the No. 1 oil from Ilford. It is thus seen that oils from different localities from the same species of Eucalyptus, are almost identical in composition, providing they are collected at the same time of the year.

No. 3. Oil obtained by mixing together the oils from nine distillations of leaves obtained from Ilford. Distilled at various times during March 1898. The quantity of leaves of *E. macrorhyncha* distilled for this research was 2,238 lbs.

Oil light reddish-brown in colour, odour fairly pleasant; yield = 0·287 per cent., (mean of the nine distillations), or 100 lbs. of leaves with branchlets gave four and a half ounces of oil; specific gravity as obtained = 0·927 at 18°. The redistillation of 100 cc. was done at ordinary atmospheric pressure, only a few drops, besides the usual water which was acid, coming over below 169·5°. Between that and 172·4° two per cent. had distilled, at which temperature regular distillation commenced. (See tabulated list.)

First fraction	23%;	sp. gr. = 0·9003,	specific rotation	=	−1·11°
Second „	32%;	„ = 0 9057,	„		+ −0°
Third „	11%;	„ = 0·911,	„		+1·54°
Fourth „	27%;	„ = 0·9542.			

Eucalyptol in crude oil—no satisfactory reaction with phosphoric acid.

(*a*) Eucalyptol in combined first and second fractions = 52·36%

(*b*) „ in whole fraction but stopping at 182° C. = 53·2%

Specific gravity of whole fraction (*a*) = 0·9035 at 18° C.; (*b*) = 0·9058 at 14° C. Eucalyptol in third fraction = 43·5%.

Digitized by Google

The oils of the first and second fractions were found to be exceedingly good, they were colourless,[1] pleasant both in taste and smell, and contained a large percentage of eucalyptol, had no rotation when mixed together, and contained but a trace of phellandrene. The third fraction was slightly coloured and acid from the slight decomposition of an ester:—1·994 grams of the oil boiled three-quarters of an hour on water-bath with upright condenser with 20 cc. of semi-normal alcoholic potash required 18·8 cc. of semi-normal sulphuric acid to neutralise the remaining potash. The fourth fraction was greasy in appearance, much resembling a fixed oil; it was somewhat coloured; it was placed in a closely stoppered bottle and in two days two-thirds of the fraction had crystallised into a solid mass; the crystallisation continued, and after five days the whole had solidified showing that this fraction consisted almost entirely of eudesmol; as it was found by a special test that slight decomposition occurred when pure eudesmol was heated to near its boiling point, and as the temperature required for distillation is so high at atmospheric pressure, it would be preferable in practice to distil at a reduced pressure.

It will be observed that differences exist in the rotation of the several oils from this species; in the first fraction of No. 1, 25 per cent. the specific rotation was $+1·11°$ while in that of the mixed oils it was lævorotatory in exactly the opposite degree, being $-1·11°$ so that increased lævorotatory terpenes were present in some of the oils. It was not found possible to keep the leaves from individual trees separate, but we have little doubt that the same want of constancy in the physical properties of the several oils from different trees of this species corresponded to that found existing in the oils of *E. punctata*.

It will be noticed by referring to the table that in the rectification of the oil of *E. macrorhyncha* the temperature required to distil the eucalyptol from the crude oil is higher than is usually

[1] In colour and appearance this rectified oil could not be distinguished from the pure eucalyptol made from it.

Digitized by Google

the case with eucalyptus oils. This is no doubt accounted for by the presence of such a large percentage of eudesmol, as the eucalyptol was found to have the usual boiling point. We have acquired data of much scientific interest bearing upon this subject, but further researches have to be undertaken before the results can be published. We hope eventually, however, to be able to account satisfactorily for the physical differences and varied composition of these oils. It is found that the chemical constitution of the many substances found existing in the Eucalypts is very different in character, although it appears that those having similar constituents form distinct chemical groups.

Oil of E. capitellata.

In the determination of the oil from this species the methods previously described were followed. The leaves were obtained in the neighbourhood of Sydney, and were distilled almost as soon as collected.

Oil from leaves collected at Canterbury, distilled 9th and 10th August 1897; red in colour, rather dark; yield 0·103 per cent. (mean of four distillations on 807 lbs. leaves), or 100 lbs. of leaves with branchlets gave nearly one and three-quarter ounces of oil; specific gravity, crude = 0·9153 at 18° C. The oil was too dark in colour to enable the rotation to be taken. On redistillation of 100 cc. the usual water was obtained at about 100°, this was acid; below 152° only a few drops had come over, by 169·5° 3 per cent. had distilled, at 170·4° distillation commenced. (See tabulated results.)

First fraction	22%;	sp. gr. = 0·893 ;	specific rotation	+7·28°
Second „	44%;	„ = 0·8992 ;	„	+3·5°
Third „	7%;	„ = 0·912		
Fourth „	17%;	„ = 0·946		

Eucalyptol second fraction = 38·4%

Although the appearance of the several fractions, the results of distillation etc., somewhat resembled the oil from *E. macrorhyncha*, yet the fourth fraction having the high boiling constituents contains only a very small quantity, if any, of eudesmol, and we hope

Digitized by Google

before these researches are completed, to be able to account for this, because the oil of *E. piperita*[1] does contain eudesmol in that fraction, although the fraction is smaller than in the case of *E. capitellata*. The oil of *E. piperita* also contains phellandrene, whilst that of *E. capitellata* contains only a trace of phellandrene. It is apparent, therefore, that the oil of *E. capitellata* resembles that of *E. macrorhyncha* and belongs to the same type. In composition the oil of *E. piperita* resembles somewhat that of *E. capitellata*, and might fill the vacant place in the list between *E. capitellata* and *E. eugenioides* did it not contains eudesmol, as the crude oil is light coloured and resembles *E. eugenioides* in that respect. The oil from *E. eugenioides* does not contain a trace of phellandrene.[2]

Oil of E. eugenioides.

This oil was obtained from leaves collected near Canterbury, and were distilled soon after removal from the trees. Two results were obtained, 670 lbs. of leaves being distilled.

No. 1. Oil from leaves collected at Canterbury, distilled 18th June, 1897; almost colourless; odour fairly pleasant; yield = 0·689 per cent., or 100 lbs. of leaves with branchlets gave 11 ounces of oil; specific gravity as obtained = 0·908 at 22° C.; the specific rotation was + 3·745°. On redistillation of 100 cc., a little water was first obtained as usual; below 166° only a few drops had come over, the distillation then commenced, but the thermometer slowly rose to 171·4° by which time 3 per cent. had been obtained, the distillation then continued regularly. (See tabulated results).

First fraction 21%; sp. gr. = 0·899, specific rotation + 4·6°
Second „ 69%; „ = 0·904, „ + 2·9°
Eucalyptol, crude oil = 31·4 %; section fraction = 34·8 %.

[1] Proc. Roy. Soc. N.S.W., August 1897, 195.

[2] The detection of phellandrene in these oils was carried out as follows: 2 cc. of the oil was added to 3 cc. of an aqueous saturated solution of sodium nitrite in a test tube, and without agitation 8 or 10 drops of glacial acetic acid was added. On standing some time, half to two hours, a crystalline crust forms at the junction of the liquids if phellandrene be present, this will separate and float in the oil. If much phellandrene be present fresh crystalline crusts form until the oil becomes almost solid.

Digitized by Google

No. 2. Oil from leaves collected at Canterbury; distilled 23rd July, 1897. Identical in appearance and odour to that of No. 1; yield 0·795 per cent., or 100 lbs. of leaves with branchlets gave 12¾ ounces of oil; specific gravity as obtained = 0·907 at 22° C.; the specific rotation was +5·246°. This oil was not redistilled.

Eucalyptol in the crude oil = 28·4 per cent.

It will be seen that the yield of oil from this species is good; the greater portion had redistilled (No. 1) below 183° C. This oil does not contain phellandrene. It appears to contain no other constituent having special interest. By referring to the table, it will be seen that this oil contained a larger percentage distilling at a lower temperature than either the oils of *E. macrorhyncha* or *E. capitellata*. The constituents of *E. eugenioides* boiling at and below 174·5° C. equalled 38 per cent., whereas the most obtained from *E. macrorhyncha* was 8 per cent. and of *E. capitellata* 22 per cent. The exudations or kinos of these three Stringybarks are identical in composition, and contain neither gum, like the Ironbarks, nor eudesmin or aromadendrin like the Boxes, etc.

In reference to the tables, we wish it to be distinctly understood that the results therein given refer only to oils investigated within three months after distillation, as we have found that Eucalyptus oils alter in composition when kept in their crude condition. Experiments are now being carried on to investigate these alterations and the results will be made known when the investigation shall have been completed.

This table gives the results of the redistillations of the oils of the three species of Eucalypts. The numbers are those given to the oils of the several species in the paper. The temperatures are corrected. The results are percentages obtained from one temperature to another, ignoring the first two or three per cent. that came over before regular distillation commenced. The (*a*) denotes the temperature where the second fraction commenced, the (*b*) the same for the third fraction, and (*c*) the commencement of the fourth fraction.

Digitized by Google

#	Species.	172·4	173·5	174·5	175·5	176·5	177·6	178·6	179·7	180·7	181·8	182·8	185·9	188	193·2	268·6	276·8	289·2
1	*Eucalyptus macrorhyncha*	...	...	...	6	...	*a* 25	...	...	35	...	48	...	60	Remaind	er placed eudesmol	In a dish to crystal	to allow lise.
2	Ditto	...	...	...	10	...	25	...	35	...	44	...	*b* 58	...	66	Remaind	er is most ly eudesmol.	
3	Ditto	...	...	8	16	*a* 23	33	38	...	40	...	48	*b* 55	...	62	*c* 66	69	93
1	*Eucalyptus capitellata*	10	...	*a* 22	37	...	44	...	48	...	55	60	.	64	*b* 66	*c* 73	90	
1	*Eucalyptus eugenioides*	8	*a* 21	38	52	65	76	81	...	...	86	...	...	...	90	Remain ing 7 per cent, appear to be devoid of eudesmol		

Table of the results of the oils of the three Eucalypts.

Eucalyptus macrorhyncha.

No.	Colour of crude oil.	Percentage yield.	$[a]_D$ crude oil.	Specific gravity crude oil.	$[a]_D$ first fraction.	Specific gravity first fraction.	$[a]_D$ second fraction.	Specific gravity second fraction.	Eucalyptol crude oil percentage.	Eucalyptol first fraction percentage.	Eucalyptol second fraction percentage.
1	reddish-brown	0·312	not taken	0·924 at 22° C.	+1·11°	0·8993 at 22° C.	+0·88°	0·903 at 22° C.	not taken	47·9	53·0
2	Ditto	0·281	Ditto	0·927 at 22° C.	+ −0°	0·9023 at 23° C.	taken with 1st fraction	taken with 1st fraction	Ditto	together 51·4	
3	Ditto	0·287 mean	Ditto	0·927 at 18° C.	−1·11°	0·9003 at 18° C.	+ −0°	0·9057 at 18° C.	Ditto	together 52·36	
					Eucalyptus capitellata.						
1	red oil rather dark	0·103	not taken	0·9153 at 18° C.	+7·28°	0·893 at 18° C.	+3·5°	0·8992 at 18° C.	not taken	...	38·4
					Eucalyptus eugenioides.						
1	Almost colourless	0·689	+3·745	0·908 at 22° C.	+4·6°	0·899 at 22° C.	+2·9°	0·904 at 22° C.	31·4	...	34·8
2	Ditto	0·795	+5·246	0·907 at 22° C.	...	...	...	...	28·4	...	...

Digitized by Google

The Eudesmol.

This new stearoptene, eudesmol, was first found in the oil of *Eucalyptus piperita (loc. cit.)*. It exists in large quantity in the oil of *Eucalyptus macrorhyncha* and may be obtained in abundance. Three methods have been successfully employed in obtaining it: (1) It may be obtained from the oil distilled about November (when it appears to be present in the greatest quantity) by placing the oil in shallow vessels and allowing the volatile constituents to evaporate, eudesmol then crystallises into a solid mass after a few days. The March distillate did not succeed so well in this respect, but it is a very wasteful method and not to be thought of practically. (2) The oil may be redistilled and the constituents boiling below 188° C. removed; this represents about 57 to 60 per cent.; the remaining 40 per cent. is then placed in shallow vessels and left a few days to crystallise, whereupon it forms a solid mass having the consistency of butter. As the presence of a very small quantity of adherent oil prevents the ready purification of eudesmol, we found it better to spread this impure product upon porous plates, whereby the adhering oil was absorbed; a whitish product was thus obtained (pressure between drying paper was not satisfactory); no difficulty being then experienced in purifying the eudesmol. (3) By complete redistillation of the oil. A fraction boiling between 269° and 289° C. is obtained; this represents 27 per cent. of the original oil. On standing, this fraction crystallised into a solid mass, being mostly eudesmol.

Considerations respecting the specific gravity of Eucalyptus Oils.

According to the British Pharmacopœia, 1898, Eucalyptus oil should have a specific gravity of 0·910 to 0·930. When the crude oil of *E. macrorhyncha* is rectified an excellent product is obtained, boiling between 172·4° and 188° C., colourless, pleasant in taste and smell, very volatile, and containing by the most rigid phosphoric acid test 50 to 53 per cent. of eucalyptol, while only a trace of phellandrene could be detected; and yet this rectified portion of the oil, comparable in all requirements with the best Eucalyptus oils, except the specific gravity test, cannot pass the tests laid down

Digitized by Google

because its specific gravity is only 0·9035 at 18° C. (Another redistillation gave an oil having a specific gravity of 0·9058 at 14° C.) Although the rectified portion of this oil (*E. macrorhyncha*), might be rejected because of its low specific gravity, the crude oil being of high specific gravity, 0·927, might be accepted as indicating an excellent oil.[1] The reason is, that besides the usual residue, this oil contains a large percentage of eudesmol (the stearoptene found in Eucalyptus oil, and discovered by us last year),[2] the fraction distilling between 268° and 289° C., representing 27 per cent. of the original oil having a specific gravity of 0·954 at 18° C. We showed in our paper on the Grey Gum (*E. punctata*) that the specific gravity of an oil was no criterion as to the amount of eucalyptol contained therein, and we are enabled in this research to further emphasise that fact. It is evident that if the specific gravity 0·910 – 0·930 be insisted upon, some excellent oils would be made to appear of inferior quality while inferior oils would pass the test. We suggest that fixing the test as high as 0·910 is both unnecessary and unsatisfactory, and that if it were insisted upon that the oils should contain 50 per cent. of eucalyptol then the specific gravity test might be reduced to 0·90 – 0·925. Another instance of the unreliability of the specific gravity of an Eucalyptus oil to indicate the eucalyptol content, is that the fraction of the oil of *E. macrorhyncha* distilling between 185° and 195° C. had a specific gravity of 0·911 and contained only 43 per cent. of eucalyptol, much less than in the previous fractions of the same oil, and which had a lower specific gravity.

We have taken this opportunity of drawing attention to the matter of specific gravity of Eucalyptus oils because of its importance. We have had our attention directed to this feature, *i.e.*, of specific gravity, during these researches, and it would be a mistake to consider an important oil like that of *E. macrorhyncha* of inferior quality because it does not come up to requirements

[1] The colour is no objection, as being of an acid character it is readily removed by agitating with potash.

[2] Proc. Roy. Soc. N.S.W. *loc. cit.*

Digitized by Google

formulated on researches limited principally to the oil of *E. globulus*, which belongs only to a type of Eucalyptus oils, and which may very well be styled the globulus type. This matter is of importance also, because it may eventually be that a large proportion of the Eucalyptus oil of commerce will be distilled from the leaves of *E. macrorhyncha* for the reason that it will be obtained practically as a bye-product connected with the extraction of myrticolorin. The yield is not sufficiently large for the extraction to be remunerative if the oil alone were the main product sought for, unless the stearoptene may be found to be of value, but in connection with the extraction of myrticolorin it has great possibilities.

Eucalyptol determination by Phosphoric Acid.

It will be noticed that the crude oil of *Eucalyptus macrorhyncha* did not react satisfactorily with phosphoric acid, although a large percentage of eucalyptol was present in the oil, as will be seen by referring to the table of results. It is only after the oil has been redistilled, whereby the fractions containing the eucalyptol are separated from the eudesmol and other constituents boiling at a high temperature, that the reaction with phosphoric acid is at all satisfactory. This test cannot be considered a satisfactory qualitative one for eucalyptol in some crude Eucalyptus oils, and with the crude oil of *E. macrorhyncha* it could not be used for quantative determinations. Other constituents besides eudesmol may have an adverse influence. When ice was added to the water bath a crystalline product was obtained, but with difficulty, and the reaction was far from satisfactory, and no attempt was made to determine the eucalyptol content quantitatively in the crude oil of *E. macrorhyncha*. It appears, therefore, that crude oils of unknown species should be redistilled before a decision can be arrived at as to the absence or otherwise of eucalyptol, when phosphoric acid is used.

The quantitative eucalyptol determinations were carried out in the following manner; the phosphoric acid was added by drops from a burette to 10 grams of the oil, using a cold water bath; thorough

Digitized by Google

incorporation was made between the addition of every two or three drops, the pink colour being taken as the end of the reaction. Drying paper as used in the herbarium for drying plants was used for the pressing, as being far preferable to blotting paper, being stronger and quite as absorbent; a copying press was used for the pressing. The cake was broken up with the point of a knife, and renewal of the paper was continued until oily indications ceased. By this method fairly concordant results were obtained, and the eucalyptol when regenerated was found to have the physical characteristics of that body, and to be almost pure. Duplicate results at least have been taken and the mean given. $C_{10}H_{18}O$, H_3PO_4 was the formula taken in the calculations. For other constituents of these trees we refer to two papers on myrticolorin by one of us, and published in the proceedings of this Society.

4. Summary of Results.

1. Baron von Mueller's classification of the "Stringybarks" is endorsed.

2. That an oil having a less specific gravity than 0·910 has been found to exist containing over fifty per cent. of eucalyptol, and answering all the tests laid down in the British Pharmacopæa of 1898, except that of specific gravity. It is thus seen that the specific gravity test for Eucalyptus oil as given in the B.P., if enforced, might be the means of excluding some excellent oils.

3. That phosphoric acid is not a satisfactory qualitative test for eucalyptol in some crude Eucalyptus oils.

4. That eudesmol, the stearoptene of Eucalyptus oil, exists in large quantities in the oil of *E. macrorhyncha* and can be readily purified.

Digitized by Google

CURRENT OBSERVATIONS ON THE CANADIAN-AUSTRALIAN ROUTE.

By Capt. M. W. CAMPBELL HEPWORTH, F.R. Met. Soc., F.R.A.S., R.M.S. *Aorangi*.

(Communicated by Mr. H. C. RUSSELL, B.A., C.M.G., F.R.S.)

[*Read before the Royal Society of N. S. Wales, July 6, 1898.*]

As a material assistance towards the successful navigation of the Pacific Ocean when making the passage between Australia and British Columbia on the steam-route between these two Colonies, I obtained sometime ago a number of current observations recorded in the log books of past voyages of the steamer *Warrimoo* dating from the 18th of June 1893 to the 1st of December 1897, and through the kindness of Captain Hay, the present commander of the *Warrimoo*, then commanding the *Miowera*, similar data from log books of the latter steamer dating from April the 9th 1896 to June the 3rd 1897, were supplied to me. These observations, together with a number which have been made by myself during twenty months on the Pacific in the steamers *Warrimoo* and *Aorangi* were found to furnish so much information as to the movements of the sea surface on the diagonal cut across the Pacific which is taken by the steamers of the Canadian Australian line, that I ventured to hope the results of my investigations might be of interest to this Society. In all sixty-two passages have been dealt with, and the currents experienced have been drafted on track charts for the month or months during which the passage is made. In this work I have had the valuable assistance of Mr. H. Reader, second officer, and Mr. F. Bayldon, third officer, of the *Aorangi* who have taken a keen interest in the work and devoted to it a considerable portion of their time during their watches below at sea.

The direction of the currents—which are given true on all these charts—are shewn by arrows with ends barbed in the direction

Digitized by Google

the stream was found to be flowing, the value from noon to noon of the observed current being shewn by the numbers beside them. The direction and value of these currents are of necessity only an approximation, being the course and distance between the position of the ship as found by observation and of that estimated by account. It will be readily understood then that accuracy is dependent upon the correctness of observation for latitude, longitude, and compass error on the one hand, and upon good steering and exactness in logging on the other. Inaccuracies due to errors in observation are as a rule small, and the same may be said in regard to the steering of a fast modern steamer, but this is not the case in respect to logging. Hand logs and patent logs alike are not to be relied upon in estimating accurately the speed at which a fast steamer is travelling or the distance she has travelled. The hand log or patent log influenced by the disturbed water in a steamer's wake will denote a rate of progress under or in excess of her actual rate, in the one condition of the vessel's trim, although it may have recorded the actual speed through the water in another condition of trim. The accuracy, to sum up, of a log will therefore depend upon the approximation of a vessel's trim to one particular condition, and no workable amount of stray line will altogether eradicate this error. In the case of a patent log moreover, the slip of the rotator will be found to vary according to the speed of the vessel, and as the mechanism, from the effect of friction, will probably after a time offer slightly reduced resistance to the action of the rotator, a corresponding variation in the rate of the machine will result. It is far from my intention to condemn the use of the hand or patent log generally. In the daily navigation of sailing vessels, and of all steamers of low, or comparatively low power, whose speeds are easily affected by conditions of wind and weather, the assistance that may be gained by their use, is in my opinion invaluable, as it is also in full powered steamers at times, notably when on account of fog the speed maintained is not uniform, or in intricate navigation, when the course has to be altered frequently upon the completion of short distances.

Digitized by Google

The only reliable method of correctly logging a full powered steamer, under ordinary circumstances, is by calculating the speed by the revolutions made by the engines, making allowance at the same time for slip, and the accuracy with which the distance run may thus be estimated, when experience has taught what slip to allow for the trim of the ship and the state of the sea, is most satisfactory.

On the run between Australasia and British Columbia the Admiralty current chart compiled by Staff Captain F. J. Evans, R.N. and Staff Commander T. A. Hull, R.N., under the superintendence of Admiral G. H. Richards, C.B., F.R.S., will be found of great assistance to the navigator, and its accuracy, considering how little information regarding the meteorology of the Pacific was available to its compilers, is astonishing.

Formerly the steamers of the Canadian-Australian line made the passage from Suva to Sydney direct, but since the month of August of the present year they have been calling at Wellington, New Zealand. Current observations between Sydney and Cook's Straits, and between Cook's Straits and Suva are as yet few, and do not call for any special remark.

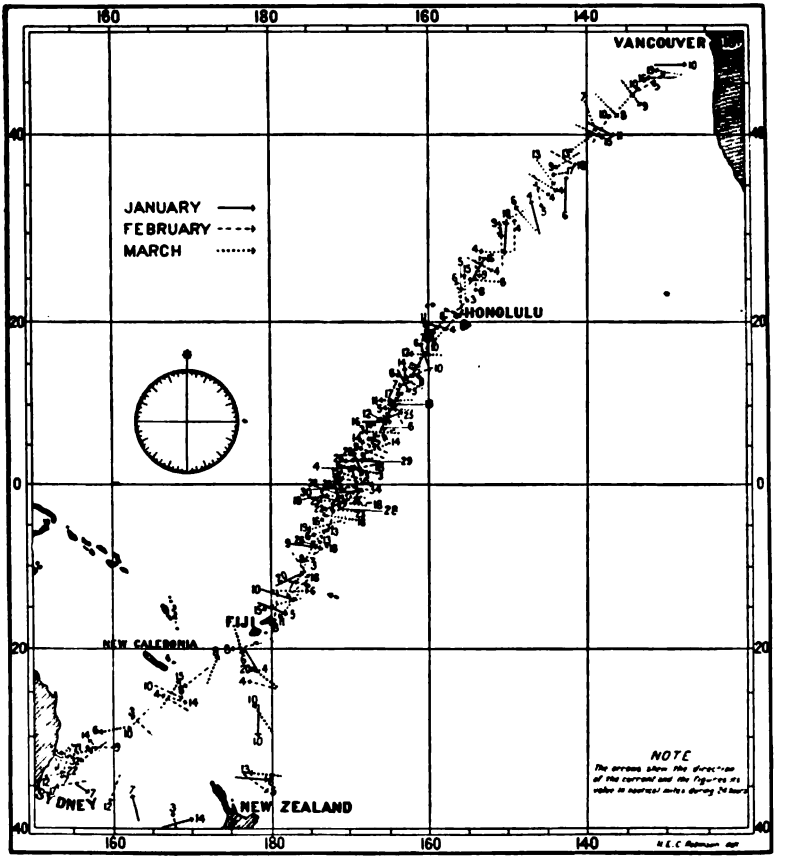
In Mr. Russell's first contribution to the Royal Society of New South Wales on the subject of current papers, he shewed how several bottles containing these papers, thrown overboard near the coast of New Zealand, were picked up far to the northward, having travelled apparently against the current known to set to the southward along the east coast of Australia. Now the Admiralty current chart shews us that the east coast current, which is as a matter of fact the equatorial current diverted to the southward on its impact with the east coast of Australia, is deflected between the 31st and 35th parallel to the eastward, and afterwards to the north-eastward by that current from the Indian Ocean which has passed through Bass' Straits and round the south coast of Tasmania. The current observations under discussion to-night testify to the accuracy of the Admiralty chart, and shew

Digitized by Google

moreover that eastward of the 160th meridian and between the 20th and 30th parallels this north-eastward moving stream meets one of its parents, the equatorial stream, and flows to the westward. Thus as Mr. Russell truly surmised, these bottles instead of travelling against the current, made a long detour with the current of many hundreds of miles.

Under normal conditions the east coast current obtains all the year round, but during southerly gales its velocity is considerably checked, if not after a prolonged spell of wind altogether arrested for the time near the coast, and the easterly and north-easterly current will be found further to the northward its strength considerably augmented. My charts shew currents setting to the north-eastward between Sydney and Middleton Reef of forty-one miles in the month of May, forty-one miles again in June, thirty-eight and twenty-three miles in October, and many other of less value at all times of the year. Between Middleton Reef and the Fiji Group following the steamer's track the set will be found to trend mainly to the westward, and to the north-westward, when southerly winds have prevailed, and to the southward when the type of weather has been northerly. Between the Horn Islands and the Fiji Group the drift current is usually to the southward or south-westward, but during the monsoon season a strong easterly set may be experienced, and this easterly set may exist as far to the north-east on the steamer's track as seven degrees south latitude. Referring to the chart for January, we see that the only current recorded between the Phœnix and Fiji Groups were to the eastward during this month. Steering to the southward at this season, it is well to make a point of sighting the Horn Islands before shaping a course for the Fiji Group, otherwise, during the thick rainy weather which usually prevails during the monsoon season the easterly currents may carry a vessel into danger. From ten degrees south latitude to the equator, still following the "Ash track," the equatorial current will be found setting for the most part to the southward and westward, and increasing in force as the line is approached. Between the

Digitized by Google

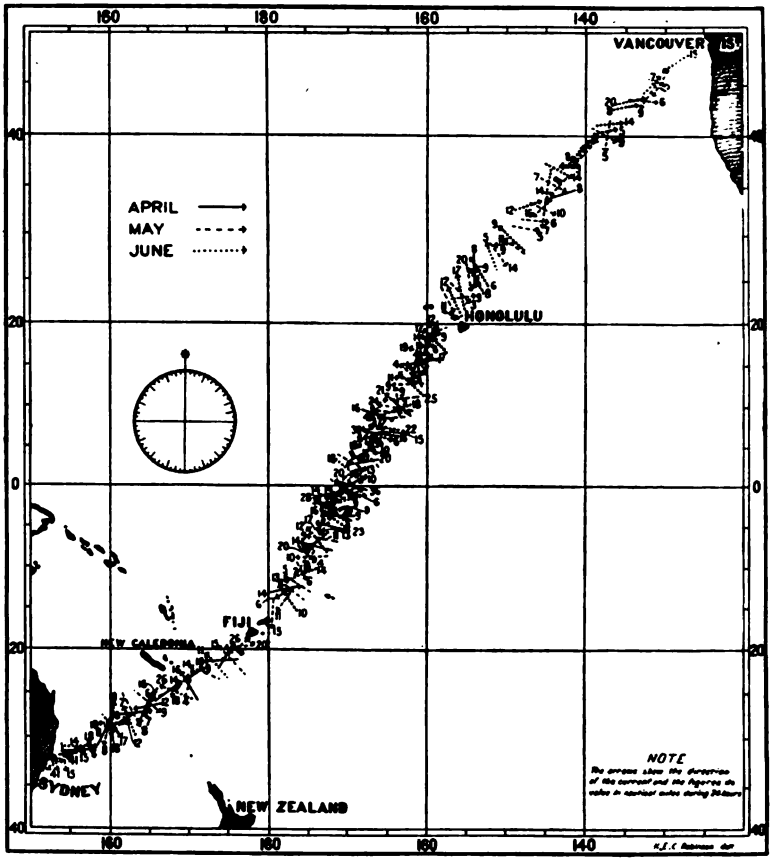


parallels of five and ten degrees south, a north-eastward and north-westward set is here and there recorded, in the months of May, June, July, and August; and to account for the same I may here remark that in May the south-east trade wind is re-established and blows steadily until September. From the southern limit of the Phœnix Group to three degrees north latitude the equatorial stream appears to attain its greatest strength on the track I am asking you to follow, and we find in my records of daily currents such values in miles as the following:—29, 20, 36, 22, 25, 23, 20, 36, 20, 28, 37, 38, 26, 24, 34, 33, 32, 39, 24, 44, 40, 28, 25, 31,

Digitized by Google

and 35. Of course there are numerous records of daily current observations of less than twenty miles; the strongest current will be found on the chart for the month of October. On a general chart for the year which I drafted, but which is not here published, the currents appeared to set indiscriminately eastward and westward, where the eastward stream or counter current may be looked for, the explanation being that the line of demarcation between the equatorial and counter currents alters according to the season, and therefore when the former still obtains at one season of the year, the latter has established its right of way, so to speak, at another season. This eastward moving, or counter current of the Pacific referred to, is analogous to the counter current of the Atlantic Ocean which goes to feed the Guinea current. These mighty ocean streams—the equatorial and counter current—run side by side in opposite directions, their surface temperatures and densities having no appreciable difference, yet they preserve their individuality as though divided by a solid barrier. Near the equator, the heaped up waters of the equatorial stream overflow where the saturated trade winds fail and precipitate their moisture, and one of the localities in which these overflows, which form the counter stream, takes place, according to the Admiralty chart, is crossed by the steamers of the Canadian-Australian line, and the records from the log books of these steamers bear out in a remarkable manner the accuracy of the chart. The latitude assigned to this counter current by the compilers of the chart, namely, between four and eight degrees north, may be considered its average limit throughout the year. My records shew that during the months of May, June, and July, the counter current may be met with between the parallels of one and six degrees north, and during August, September, and October, between the parallels of five and nine degrees north, and it should be noted that during these months the south-east trade winds blow without intermission. During December we find two observations of counter current between the equator and the fourth parallel, and three observations of current flowing to the north-eastward

Digitized by Google



and east-north-eastward between the eighth and eleventh parallels of north latitude, which will not, for reasons given hereafter, be considered as belonging to the counter current proper. During February and March no eastward moving currents have been recorded, but in April two observations of counter current are recorded, one between the third and fifth parallels, and one between the eighth and tenth.

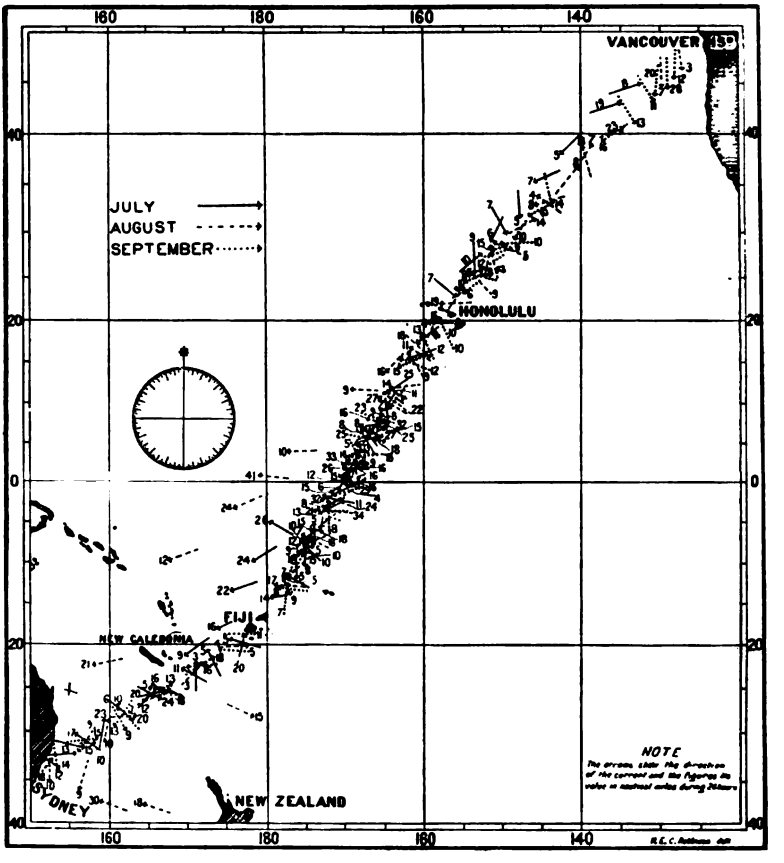
Disregarding these last two observations, which may be looked upon as exceptions to prove the rule, we find that from December to March inclusive, *i.e.*, during the monsoon season in the region

Digitized by Google

about the Fiji Group, and westward to the Coral Sea, when the wind between this and the equator is drawn to the north-eastward, the equatorial counter current slackens, or is altogether absent, and that it is questionable whether it has much value during April. When this current first separates from the parent stream it flows to the northward and north-eastward for probably a hundred or two hundred miles before it turns to the eastward. There appears to be some evidence to shew that a considerable body of the counter current retains its northward course as an under current, coming to the surface again to the north of ten degrees north latitude, and mingling with the waters of the north-east Trade Drift, but still maintaining its course to the northward.

Before my acquaintance with the Canadian-Australian route commenced, Captain Charles Bird—a very keen observer whose observations are amongst those that may be considered to have most weight in judging the value of these records—gave me some useful information as to the winds and currents he had experienced on his voyages across the Pacific, and among other things he told me, which greatly interested me, was the fact of a set to the northward dead against the north-east trade wind having been several times experienced by him between the parallels of ten and fifteen degrees north latitude, on the run between Fiji and Honolulu. Personal experience as well as the testimony of the *Warrimoo's* and *Miowera's* log books have fully borne out Capt. Bird's statement, and by referring to the charts we shall find in January a set to the north-north-east of thirteen miles, and a set to the east-north-east of twenty-five miles, between the parallels of eight and eleven degrees north; and again a set to the north of fourteen miles, and a set to the north-north-west of six miles, and a set to the north-north-east of fifteen miles, between the parallels of twelve degrees and eighteen degrees north, all in the heart of the north-east trade winds, and travelling against it. The question in my mind arises, is this the equatorial counter-current, credited with having continued its northward course as an under current, come to the surface?

Digitized by Google



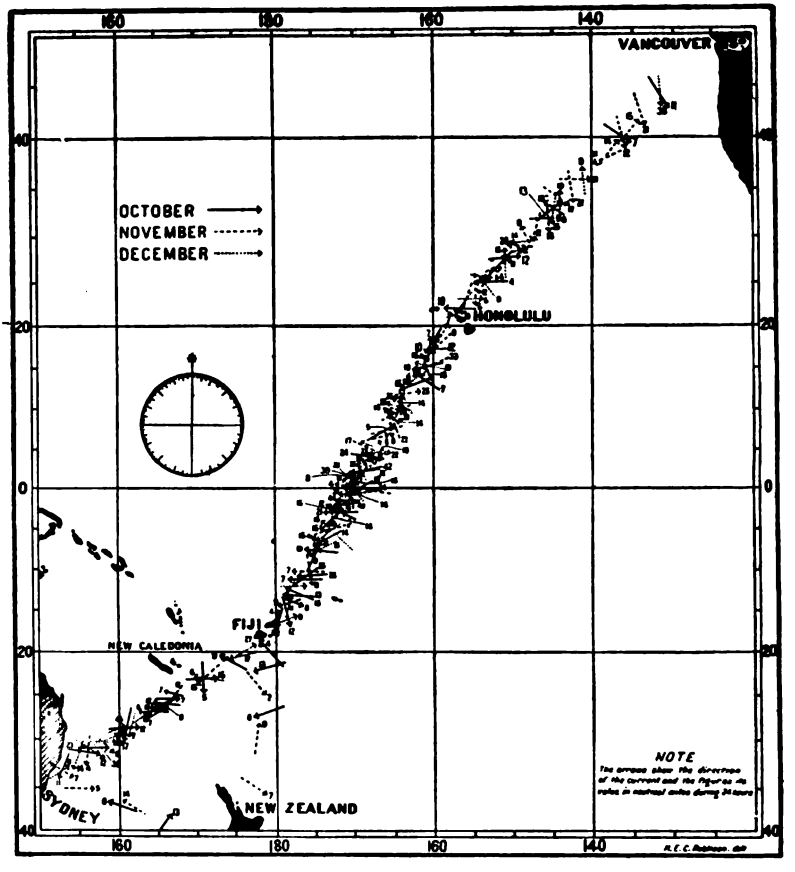
The January chart has been referred to in order to point out the phenomenon as shewing the extreme southern limit of the set during this month, but this set will be found cropping up between the tenth and twentieth parallels on the charts for each month of the year. Between the tenth and the eighteenth parallels, excepting when the northerly current referred to is met with, the north-east Trade Drift sets to the westward, its direction varying from south-west to noth-west, and approaching the Hawaiian Islands southerly and south-westerly currents may still be considered to prevail, but northerly and easterly have frequently been experienced

Digitized by Google

and may be expected when the north-east trade wind fails and gives place to southerly winds; the southerly season is coincident with the northern winter, but it must be conceded that my records tell of northerly and easterly currents, not only from October to March, but at all times of the year.

Continuing our voyage from the Hawaiian Islands to British Columbia, the data in my possession at first sight appear to supply evidence of a conflicting nature, but I shall hope to prove that this is not in reality the case, but on the contrary, the direction and force of the current at different seasons of the year may be predicted on this portion of the voyage with considerable accuracy. The north-east Trade Drift in approaching the Hawaiian Islands from the east-north-eastward is deflected under normal conditions to the north-westward. It is probable that the prevailing westerly winds of the north Pacific, between the thirty-fifth and fiftieth parallels, produce the surface current setting to the eastward which is augmented by the Kuro Siwo or Japan Stream which has found its way thus far across the Pacific, and mingling with the north-east Trade Drift deflects it to the north-eastward, which direction it retains until near the north-western shores of the American Continent, when it is again diverted to the south-south-east and ultimately becomes the Mexico current. This circulation roughly outlined, is reversed or modified in places according to the season, changes in one way or another consequent upon an alteration in the distribution of atmospheric pressure having a marked effect upon it. The centre of the north Pacific anticyclone, or area of high pressure, oscillates during the year between the one hundred and thirty-fifth and one hundred and fiftieth meridian of west longitude and between the thirty-eighth and forty-second parallels of north latitude. This area of high pressure is furthest north and west from May to October, attaining its extreme north-west position in August. It is farthest south-east from December to April, attaining its extreme south-east position in March. During the former months the north-east trade winds blow steadily from about the twenty-sixth degree of

Digitized by Google



latitude, and on the charts for June the only currents recorded are to the north-westward, on our track between the Hawaiian Islands and the thirty-first parallel. In July the records are conflicting it is true, but the August chart shews strong evidence of westerly north-westerly and southerly currents. In September the north-east Trade Drift is strongly marked, taking a south-westerly direction before curving to the westward, and the October chart gives one observation of current to the south-westward and two to the westward. From December to March inclusive, the north-east trade wind is intermittent, and southerly and south-westerly winds

Digitized by Google

are not unfrequently experienced in the vicinity of the Hawaiian Islands, and to the north-eastward. The charts of December, January, February, and March have not the characteristic features referred to above, but bear traces of an interruption in the north-east Trade Drift, and of an occasional set to the northward.

Following our track between the thirtieth and fortieth parallels, the direction of the surface currents are found to vary according to the direction of the wind, but they shew a southerly tendency. The January and December charts record north-east currents and the strong south-west winds which prevail between November and the latter end of February lead us to anticipate this. From the fortieth parallel to within about six miles off Cape Flattery, where the counter current setting to the northward obtains, the set experienced is always to the southward and eastward, excepting when checked by winds from south-west and south-east which blow with great violence during the winter months. During these months the main position of the centre of the north Pacific anti-cyclone is situated in about thirty degrees north and one hundred and thirty-eight degrees west, the pressure to the northward of the forty-fifth parallel is low, for the whole of the north Pacific and cyclonic systems traverse that ocean from west to east often in quick succession, and under similar conditions as are found to exist in the North Atlantic. In December last during a hard south-east gale, the mercurial (Board of Trade) barometer standing as low as 28·90, a strong set to the north-westward was experienced from a position about three hundred miles south-west by west of Cape Flattery to the Straits of Juan de Fuca.

At no distant date I understand the Admiralty will publish current charts for the Pacific Ocean for different seasons, if not for each month of the year, and then these records of ocean currents, the study of which at times has seemed to me like the perusal of some stray fragments of a torn up document, will have complete contexture, and it will be known whether the theories adopted by me in their interpretation are correct or otherwise, but in the meantime I shall venture to hope they may be of some interest to those who are interested in such matters, and of some value to those whose lot it is to navigate these tracts of the North and South Pacific Oceans with which it deals.

Digitized by Google

WATER-SPOUTS ON THE COAST OF NEW SOUTH WALES.

By H. C. RUSSELL, B.A., C.M.G., F.R.S.

[With Plates II.–IX.]

[*Read before the Royal Society of N. S. Wales, August 3, 1898.*]

THOSE who have the best opportunity of seeing, tell us that on the coast of New South Wales water-spouts are seen very frequently, often in groups of three or four, but the recent display off Eden is by far the grandest that I can find on record, for here occurred in the short space of five hours, fourteen complete water-spouts, and six others more or less incomplete, making twenty in one group, or rather from one great mass of cloud.

They were seen on May 16, 1898, and came as such displays generally do, quite as a surprise. For on that morning there was nothing remarkable in the antecedent weather; a low pressure system of slight intensity was at that time over the western districts of Victoria; the isobars were far apart and the winds, if any, were light, but conformed to the isobars. At Eden and generally in South-east Australia, it was fine and calm in the early morning. At 9 a.m. Eden reported a light north-west wind with fine weather and smooth sea, and these conditions were general within a radius of one hundred miles of Eden. Very early in the forenoon a great heavy bank of cloud appeared on the eastern horizon and became more and more dense as it drifted towards the shore. The cloud gradually rose above the horizon, and there was a flickering as if electrical discharges were going on between the cloud and the sea, but there was still nothing to suggest, much less to indicate what was to follow.

Mr. Pilot Newton saw the first of these water-spouts about 11 a.m., it seemed to have come into existence suddenly, and was when first seen about a mile long and as straight as a shaft, and

Digitized by Google

was estimated to be thirty times as high as a clipper-ship, say 5,000 feet. When first seen it was in the north-east distant about eight miles, and it drifted rapidly to south-west until it was only three or four miles from the coast, and then suddenly disappeared.

The experience of Mr. D. R. Crichton, Mining Engineer, who observed these water-spouts is unique, for he, as appears in the following account of the occurrence, was able to watch carefully through the telescope of his theodolite eight of the water-spouts, what he saw is best described in his own words, as follows :—"I had the opportunity of observing this most unusual phenomenon of such a large number of water-spouts at one time. While looking at the first one the idea struck me of putting up my theodolite for observation, and by the time I had got it set up and adjusted, the nearest and largest water-spout disappeared. At the time the intention was to make measures for my own information; had I known that you wanted them, I would have taken more observations. Since I received your letter I have gone carefully over my notes and worked out the results, which I have much pleasure in sending to you.

"There were fourteen clear and distinct water-spouts, *i.e.*, reaching from clouds to sea, commencing at 10·45 a.m. *Plate 2* was made from an oil painting by Mr. A. J. Nicholson of Eden, and shews four out of the twenty water-spouts that were seen at Eden, New South Wales, Latitude 37° South. The first one was approximately eight miles off the shore, and the others came at intervals afterwards, each one a little farther from the land; the last one that was distinctly visible was about thirty miles from the shore at 3·50 p.m. There appeared a few broken columns for an hour afterwards, but they were hazy and indistinct. The weather all the time was calm and there was no sea. The one I measured with the theodolite was the second and largest one, and the nearest to the land. I have computed the distance at nearly eight nautical miles from where the theodolite was standing in Imley-street, Eden. The height above the sea of the top of the inverted cone, *i.e.* to top of this water-spout was 5,014

Digitized by Google

feet. The cones at the top and bottom of the spout were about 100 feet in diameter, and the length of each cone from its base to the points at which the spout became parallel was about 250 feet. The spout or coloumn when formed by the junction of the two cones appeared to be about ten feet in diameter and perfectly symmetrical from end to end.

"Looking through my telescope I could distinctly see the commencement of each water spout. First there came a violent disturbance of the surface of the otherwise smooth sea, and I could see the rotary motion of the waves over a surface about one-third of a mile in diameter, large quantities of broken water being raised up; as the rotary motion accelerated the diameter became less, the spray became visibly denser and in two or three minutes the base of the whirlwind was formed. Then it rose gradually as a white misty topped column—the misty part preceding the denser part by one hundred to one hundred and fifty feet; this went on for three or four minutes, and by that time the misty topped column or cone had risen two-thirds of the way up to the clouds, *i.e.*, 3,300 feet. During this time the clouds had formed an inverted cone reaching downwards and egg-shaped at the point, then the point of the cloud cone seemed to be alternately dipping down and receding with an interval of about thirty seconds between the dips, but all the time it was getting longer and reaching down towards the misty cone that was stretching upwards from the sea, until finally the two cones met and suddenly all became symmetrical and dense without any visible rotary motion. All the misty matter or cloud was absorbed. The column then remained unchanged for ten to twelve minutes; all this time the overhanging cloud appeared to be getting denser and moving slowly eastward, the haze on the ocean perceptibly dragging until the water spout got out of perpendicular, about 10°, then it gradually, *i.e.*, in three or four minutes, again assumed the misty form and divided in the middle, the top rising slowly, in one and a half to two minutes, and the lower half sank to the ocean in about one minute, where it caused a violent disturbance and much broken water. I could see the rotary motion again directly the column became misty.

Digitized by Google

"I closely observed through the telescope eight out of the fourteen water-spouts, and they were all columns of broken water in which the rotary motion could be clearly seen until they met the cloud cone, when the column or spout formed and the rotary motion could not be seen until the column broke; I could then see the misty matter flying round and receding. The last water-spout but one appeared to take its start out of the "debris" of the one that preceded it.

"I have seen many whirlwinds in the Carcoar and Forbes districts, and once when travelling in the Carcoar district I arrived at a water hole just after a whirlwind had scooped up and carried away all the water, so that I was familiar with the effect of wind vortices before I saw these whirlwinds."

Mr. Francis, Signal Master, South Head, Sydney, has observed many water-spouts, and supplied me with many valuable observations and sketches of them, from which *Plates* 4 to 6 have been made. These throw much light upon the phases of water-spouts not reproduced in the Eden display. If we were to overlook these records we would miss much important evidence of the varying phases of water-spouts, and it is evident that the life and character of waterspouts cover a great amount of variation in the phenomena. In the small number herein reported we have the tall straight pipe a mile long, and the short dumpy one in Coogee Bay (*Plate* 4) less than one hundred feet long, and the completed coil of Captain Taplin, (*Plates* 8, 9) or, referring more to details but which are nevertheless remarkable, we find at Eden and in some instances at South Head the water-spout is formed by cones projecting from the sea and the clouds, the union of which completes the water-spout. (*Plates* 4, 5, 6.)

Again, the first glimpse of the water-spout of March 2, 1895 (*Plate* 6) is like the one at Eden vertical and straight, but the South Head one developed cones of cloud and spray above and below, while the Eden one disappears suddenly without the retreating stage with cones above and below. That the lower cone (*Plate* 6, No. 2) was spray is evident from the fact that the spout could

Digitized by Google

be seen through it down to the water, that it was a phase of decreasing energy is shown by the fact that it ceased to be a complete spout a few minutes afterwards No. 4. Again Captain Taplin's coil water-spout is very remarkable (*Plate* 8). The spout, although elongated to an unusual length and swaying about in the wind, maintained its vitality until the snake-like form swung into a complete coil and brought about its own destruction, by making its vital force of rotation meet from opposite directions at the point where the coil was completed, and the forces being equal and opposite destroyed itself.

Still another phase is shewn in Mr. Francis' water-spout of June 6th, (*Plate* 5), where the spout comes from the cloud to the water without a sympathetic cone below, and another on the same day, a long tapering cone, which appeared without a corresponding disturbance below. The distance, fifteen miles, may have hidden a cone below, but it is noteworthy that the second one on the same day and only three miles distant, shews no cone below, although seen at 2·10 p.m. when light was abundant.

Still another phase is seen in one of the water-spouts on March 21st (*Plate* 3), which was painted by Mr. Louis Frank, an artist well known for his accuracy in delineating natural features. Its character is something like those (*Plate* 3) of June 6, 1894, in that it is a cone from cloud to water, but its width, judged by what we ordinarily see in water-spouts is altogether out of proportion to the length, but something like it was seen by Mr. Surveyor Campbell on Sept. 9, 1894 over the land, (see appendix) and Mr. Louis Frank saw the Coogee water-spout coming over the land before it got into Coogee Bay. On shore such a cloud of revolution would be called a "tornado," and this particular one is very like the well known American one as pictured in books. Water-spouts have been seen to come on shore and gather up sand instead of water, and the Coogee water-spout is a tornado gone to sea. We have here then the extremes in water-spout lengths, Eden affording the maximum, a mile long, and Coogee the minimum of one hundred feet.

Digitized by Google

As evidence of the character of the small vortices, I may mention some facts that have come under my notice before offering any explanation as to the origin and character of water-spouts.

Some years since, the driver of the mail coach from Goodooga to Walgett, in this colony, was very much surprised to find the road for a quarter of a mile alive with fish floundering about; the fish were such as are found in the swamps and tanks of the district. The ground also was very wet and the fish numerous and lively, but the origin of them was a mystery; a wider experience said that evidently a tornado had passed over a swamp or tank and carried up the water and the fish with it; there was no other possible source from which the fish could have come, unless they were carried from the river.

Another instance: In a heavy rain storm, with thunder and lightning, on September 21st, 1888, on a station called "Gnalta," west of the Darling River, and one hundred miles north-west of Wilcannia, the rain fell in torrents, and after it was over three fish were discovered in one of the open iron tanks which was kept for watering the garden and usually supplied with water from a well. The whole country was at the time suffering from a very serious drought, and the Darling River, distant more than one hundred miles, was the nearest possible source from which the fish could come.

Another instance: The Burrangong *Argus* reported that on January 24th, 1881, a number of small fish were found in the bush after a heavy rain storm. The creeks in the neighbourhood were all dry, and the only water-hole was much lower down, so that the fish could not have come from there, and they must have been deposited in the bush by the heavy rain, the storm having taken them out of some permanent water-hole.

FIRE FROM A TORNADO.

An interesting proof of the velocity of the wind in a tornado was given to me by Mr. Richard Hodnett of Carrington Park, fifteen miles east from Bourke on the north side of the river, who

Digitized by Google

describes it as follows:—"On January 3, 1889, I was riding towards a sandhill about four miles out from the homestead when I noticed one of the largest whirlwinds I ever saw travelling directly across my track, and I stopped the horse so that I could watch its movements, and at the same time let it pass by, because I knew very well what these storms are capable of in timbered country. It was travelling down the hill at a terrible pace. A good sized dead pine tree stood in its way, and I waited to see the effect the tornado would have on it; all the pines about had, like this one, been dead for years. The tornado at this time was fully twenty feet in diameter at the base, tapering upwards to a considerable height, and was making a loud buzzing noise, throwing out from its circle sticks, sand etc., and revolving with great velocity. In a few moments it was on to the dead pine, and almost instantly the top and branches were torn off, breaking up and grinding in the centre. After it had passed, I rode up, and to my surprise, found fire and smoke at the butt of the tree. I put it out as quickly as possible to prevent it from spreading. I rode away puzzled, and after thinking it over returned to the tree and examined it more carefully. I found no other indications of fire except where I put it out; there was a good deal of broken wood about the tree but no sign of any previous fire, nothing in fact except the little fire that I put out and that was only superficial. Indeed had there been any fire at the tree before the tornado reached it I must have seen it." Perhaps no better proof of great velocity in the vortex could be found than this case of the production of fire.

The well-known sand spirals of our western districts are akin to the water-spouts and throw some light on their origin, the late Sir G. B. Airy said he thought they must be caused by purely local conditions. On the ground the air was motionless under a blazing sun and a clear sky, the sun's rays direct and reflected by the earth, heated up the air near the soil and gave it an ascensional tendency, but it could not rise because a steady wind was blowing overhead at a considerable elevation; this served

Digitized by Google

to keep down the heated air which was all the time trying to rise. Now and then some little vortex in the overhead current gave the lower heated air a chance to screw its way upwards and through the overhead current; this vent once established is maintained by the great extent of heated air on the earth's surface, all of which is seeking an opportunity to rise. Sometimes ten or more are all going on at the same time, and they travel slowly eastward. They never exhibit any great energy, just enough to carry up fine dust in a spiral two or three feet in diameter. The air is very dry and uniformly heated, and the increase of the ascentional force by the condensation of moisture as it rises, which, as we shall presently see, is such a powerful factor in the formation of a water-spout is altogether wanting in sand spirals.

A WATER-SPOUT VIEWED FROM ABOVE AND BELOW.

M. Kaemtz, the late able Meteorologist, in his work on Meteorology, says, page 393: "I was on the Rigi, and looking down I examined masses of fog preceding towards each other in the valley of Gulden, whilst around me, as I stood on the mountain, the air was calm and the sky serene. At the end of a few moments the masses of cloud united, and I observed a gyrating movement in the midst of them; the fog then extended upwards with inconceivable rapidity, and violent gusts of wind drew from it hail and rain. In the meantime the temperature had fallen, so that the water in the teeth of my anemometer was congealed. A friend of mine, who arrived in the evening, told me that 'on the Lake of Quartre Cantons he had experienced a violent storm, during which the clouds were driven in different directions, and at the same time he saw a water-spout.'" Kaemtz calls particular attention to the inconceivably rapid extension of the fog about him, due no doubt to the moisture-laden air carried up by the water-spout below, which expanding by relief of pressure as it rose higher and higher on the mountain, and at the same time affected by the cold of these regions, would of necessity deposit much of its moisture as fog. This conversion of the water-vapour into particles of water, *i.e.* fog, would increase the partial vacuum and

Digitized by Google

thereby add energy to the water-spout, and this intensification would go on until pressures above and below were in equilibrium, or the water-spout became interrupted. Thus Kaemtz's fortunate experience tells us the whole story of the origin and formation of a water-spout.

In every case the water-spouts on this coast, which have been reported to me, have come from great masses of cloud. (See details in Appendix). As to the extent of these enormous clouds, no special observations have been taken, but the observer at South Head records that one of them, four miles from the coast, extended from south-east to north-east, and therefore must have been at least eight miles long and of considerable breadth, otherwise there would not have been water-spouts under it. The cloud shown in the photograph here reproduced (*Plate* 7) was distant fully five miles and exceeded considerably the field of view in the camera, which was 80°; at the lowest estimate the cloud must have been ten miles long and fully half-a-mile in thickness or vertical depth. The cloud mass at Eden was large and conspicuous when it was thirty miles away.

It is obvious that such masses of cloud, resting over warm water in calm or almost calm weather, must be in a state of unstable equilibrium. The want of wind allows the warm humid air to accumulate under the great extent of cloud, being warmer than the surrounding air its tendency is to rise. The cloud itself is in unstable equilibrium, the parts constantly readjusting themselves with much energy, as can be seen with aid of a telescope. This motion at times causes partial breaks, as seen at A *Plate* 7 from a photograph of such a cloud, when this break makes the cloud weak enough for the confined, heated, and moist air below to force its way through, this confined air rushes up through the cloud taking on a vortex motion, and its moisture condenses as it rises, increasing the partial vacuum and accelerating thereby the uprush. The energy of the water-spout depends then upon the temperature and moisture of the air below, and the vertical thickness of the cloud, through a hole or pipe in which the heated air finds a vent into a

Digitized by Google

cold space. The rising air under such an impulse would at once be thrown into a well-defined vortex. In illustration of this we refer to the water-spouts at Eden. There the cloud itself was seen to be in circular motion, and therefore every vent in it with uprushing air became a water-spout; and the experience of Kaemtz on the Rigi shews how rapidly comparative slight differences of density and temperature may develop into a most violent vortex or water-spout.

Such are the simple and ordinary conditions which generate water-spouts; given the wide spread mass of shower cloud covering many square miles of a warm ocean current, and water-spouts are the natural and necessary result. Many vortices originating in this way never run on to completion; a cone of mist descends from the cloud as proof of the existence of a vortex motion, but this must increase until the space from the sea to the clouds is spanned by a vortex tube, which we call a water-spout. Many get half-made and are seen as cones hanging down from the clouds; some have cones from cloud and sea, and yet die away, but when these upper and lower cones unite, instantly a new energy takes command and the cones contract, leaving a tube parallel from end to end, and joining sea and cloud. The tube may be two or three, or perhaps twenty feet in diameter, and it is so light that it sways about like feathers and bends in curves before light winds. In one remarkable case as we have seen herein, it stretched and swayed about and formed a complete loop. So long as the tube maintains its uniform size its life seems assured, but if it gets uneven as in *Plate* 5, where it got smaller at the ends, and in *Plate* 6 it got smaller at the middle; these conditions seem always to indicate the approaching death of the vortex.

The opinion that the tube when complete carries up large quantities of water as a metal tube carries water, seems to be held by many persons, but the facts here collected have convinced me that it is erroneous. In the first place these water-spouts are sometimes a mile long and vertical; if we suppose it to be full of water and in a metal tube; the pressure on every square inch near

Digitized by Google

the sea would be one ton; in a water-spout tube the confining power is the wind which, at the greatest velocity we know, has only power to lift or press upon anything half-a-pound to the square inch, so that it is evident that the wind cannot confine and carry up such a column of water. Again, a vortex in water forms an empty tube round which the water rotates in its descent, and if we look at a sand spiral we see it whirling round with an empty centre, and the small tornado and the larger cyclone have their dead centres round which all revolve. What does happen is that the wind breaks the water up into spray, with the particles or drops small enough to be carried by the wind blowing at the time. There are many observations in which the water was seen to be broken up into spray in this way, and it is evident that spray would be carried by the wind round and round the tube, rising spirally all the time. The stronger the wind the more spray it will make and carry with it, and its formation at the foot of water-spouts is one of the most prominent parts thereof; many have remarked the spray as rising abundantly before the spout forms; Mr. Crichton saw the spray carried up as a cone three thousand feet, Mr. Francis, at South Head, records the same thing, but not so high, and it is a matter of common observation. When, therefore, a water-spout forms, the wind forces the water at its foot into spray, the quantity increasing very rapidly as the velocity rises above forty miles per hour, for when the velocity rises to fifty-seven miles the pressure or force of the wind is twice what it is at forty; and at eighty miles per hour the force is four times as great as it is at forty miles. This spray is carried round the vortex or water-spout, not into it. In a large water-spout, with violent winds, enormous quantities of water would be carried up in this way, and if a sudden break in the water-spout takes place, as in the one reported by Capt. Taplin, the wind suddenly ceases and the spray falls in mass as if it were a continuous flow of water; falling as it does from great altitudes, one can understand its power of destruction; what that means is indicated by the case in which soil to the depth of seven feet and a mile long was carried away by the water from a burst water-spout.

Digitized by Google

It thus appears that a water-spout of great energy may originate under conditions in which little energy seems to exist; given a massive cloud of great extent floating over warm water on a calm day, and a water-spout may be formed at any moment. The cloud is made up of parts of unequal density, and is necessarily in constant motion, owing to the inequalities of its own parts and the pressure of warm air from below; if this motion makes a vent or vertical hole in the cloud, the warm air flows up, gets some rotary impulse and a water-spout is formed at once, its size and energy depending upon the difference of temperature and elevation between the air below and above the cloud.

Every one who has watched great masses of cumulus clouds has seen rounded masses rising above the general level; these are the natural result of a vortex in the cloud bringing up the moist air from its lower levels to its higher and colder regions, where it deposits moisture and builds up the domes that cap the cloud.

Appendix.—List of Thirty-eight Water-spouts seen on the Coast of New South Wales.

December 17th, 1888.—On the voyage of the s.s. *Rotomahana* from Auckland to Sydney, she passed under masses of heavy rain clouds, sixty miles from the Port Jackson Heads. From one of the dark clouds a long tapering cloud descended, and a few minutes later another tapering cloud formed and slowly descended until it was the same length as the first, then both descended until they reached the sea, which was immediately lashed into fury and ascended in a cylinder form some twenty or thirty feet high. Then suddenly the tapering form of the clouds changed to long ribbon-like stripes, this lasted about ten minutes; then a few vivid flashes of lightning were followed by peals of thunder and the water-spouts were dissipated in a heavy shower of rain.

March 18th, 1891, South Head Signal Station, Sydney.—At 5 a.m. a heavy bank of cloud was seen coming from the south; from the cloud a large funnel shaped water-spout tapered to a point at the sea, and when it had moved northwards and was due

Digitized by Google

east from the station about a mile from the observer, it appeared to break in the centre with a loud report (probably a thunder clap), and the lower part fell to the sea while the upper part rose to the clouds. The disturbed water at the bottom of the water-spout seemed as wide as the signal station. Mr. Gibson, then Chief Signal Master, adds, "I have seen five of these water-spouts during the past six months."

"At 5 p.m. March 18, another water-spout was seen to the east, distant five miles and moving rapidly to north, the water-spout lasted about twenty minutes, became very long and swayed about with the wind, but kept its tube-like form; at the junction with the sea the water seemed to be very much disturbed. The whole scene lasted twenty minutes, and in the end seemed to fade away and disappear, the wind was blowing (Beaufort's scale) four to five.—G. Gibson, Signal Master."

March 21st, 1891.—A very remarkable water-spout was seen on this date by Mr. Louis Frank our well known artist, living on the shore of Coogee Bay; he had risen early with the intention of going for a ride, when a violent storm with thunder and lightning was seen coming from south-west into the southern side of Coogee Bay, heavy rain began to fall and enormous hailstones, the largest he had ever seen, fell about him; looking out he saw the water-spout between the shore where he stood and the island in Coogee Bay—that is within a quarter of a mile from him. When the lightning flashed about the water-spout he could see it distinctly although it was only dawn, and a very dark one, owing to this storm. In a letter to me, written at my request, Mr. Frank, says: "I made at the time I saw the water-spout two sketches of it in colours; they are true representations of what occurred. I saw it from the beginning of the water display, it seemed to come from south-west over the sandhills as a whirlwind. When I saw the waterspout it was quite near the shore, and when the lightning was brightest at the back, I could see it all very distinctly; it moved very quickly out to sea towards north-east. The rain then suddenly ceased, and I could see a second water-spout more to the

Digitized by Google

north as shewn in the painting. Our place was completely flooded and after it was over we carted thirty loads of sand and rubbish out of our stable yard. I have lived in India for thirty years and have seen many water-spouts, but I never saw one with such a large body of water as this one." The photograph of the painting (*Plate* 3) shews the water-spout as it appeared during a few seconds of a lull in the storm.

Same day, March 21st 1891—At Jervis Bay Light House a large water-spout was observed at 9·25 a.m. five miles south and moving to south-west. At 10 a.m. three more were seen, two eight miles north and one three miles east. These water-spouts all started from very heavy rain clouds; the longest was straight up and down and the top seemed to be four times as high as a full rigged ship (say 650 feet).

October 14th, 1891.—"At 8 a.m. this morning," writes Mr. Surveyor Sloman, "I observed a water-spout off the Waverley Cemetery distant about a quarter of a mile; the spray caused by its contact with the ocean rose to a considerable height. The water-spout descended from a dark heavy-looking cloud, which was high up and the long snake-like water-spout seemed to sway about with the wind."

May 13th, 1894.—On this date the Signal Master, Sydney, reported that a very large water-spout was seen descending from a dark heavy mass of cloud coming towards the observer with the south-east wind. When it was about four miles distant, he could see it distinctly by the light-house revolving light; it appeared to be very bulky and wide at the top and tapered down to a point close to the water, it was slightly curved, directly under it the sea was all white foam. It was visible for nearly half an hour. Thick heavy rain fell directly after it was broken up.

June 6th, 1894.—At 1·30 p.m. a large water-spout was seen by the Signal Master, South Head, Sydney, its direction was south-south-east, distance fifteen miles; it appeared to be fifty feet in

Digitized by Google

diameter at the clouds and ten feet at the sea surface, it was estimated to be four times as high as a ship's masts, say 650 feet, and lasted fifteen minutes. At 2·10 p.m. of the same day another water-spout formed under a dark cloud about three miles east of the point at which the earlier one was formed; it was not so large and of a much lighter colour, but did not reach the water and lasted only ten minutes.

August 17th, 1894.—On this date the Signal Master at Sydney reported a water-spout forming from a dark cloud six miles distant to south-east, wind south, fresh. "The water-spout was travelling fast and seemed to be taking up great quantities of water during the whole time it was visible; it disappeared at 5 p.m. twelve miles distant in north-north-east. The size and form changed as it went along, and all the way the water under it in a circular spot about twenty feet in diameter was white like foam as if water was being sucked up or poured down. (*Plate* 4, Figs. 1 to 4). When it was about eight miles to north-north-east and close in to the land the spout got larger, and shortly after it extended downwards to the water and then became the same width from cloud to sea (Fig. 5); at this time although twelve miles distant, it was clearly defined. My rough estimate would make the greatest diameter sixty feet, and length under two hundred feet, but when it extended to the water (*Plate* 4, Figs. 1 to 6) it must have been four hundred feet long."

August 18th, 1894.—Mr. Richard Taplin, Master of s.s. *Burrawong*, writes:—"When fifteen miles south of Seal Rocks and going south we saw before us a waterspout in the midst of a black and heavy looking rain cloud; it looked like a bright funnel and the tube descended to the sea, which it lashed into a fierce whirlpool, (*Plate* 9) it was travelling to north-west and passed us three-quarters of a mile to westward. I estimated the speed it was travelling forward at about twelve to fifteen miles per hour. The second one was not so large, but otherwise very similar, and it passed away in the same direction. The third and last one was very beautiful; it formed under the south-eastern extremity of the very

Digitized by Google

dark rain cloud, and it travelled in the same direction as the other two. Its funnel-like shape was like the first one, but it was much longer and closer to the ship, so that we could see it very well. As it came bowling along at the rate of twenty miles per hour, we could see the water spouting up in a continuous and uniform stream right up to the cloud. When the waterspout was about two miles to the north-west of our ship, it suddenly presented a very curious and fantastic shape; it became very long, swaying and coiling about like a serpent. All at once it made a complete coil, (See *Plates* 8, and 9) then burst, great quantities of water poured out of the lower part of the coil, and in a few seconds one of the most beautiful sights I have ever witnessed during my seafaring career, vanished as completely as if it had never been in existence."

September 9th, 1894.—Mr. W. D. Campbell, Surveyor, reports that on that date he was in the Centennial Park, and looking southwards he saw a water-spout come down from the clouds; it did not present the usual thin tapering cone, but was more like a cylinder slightly enlarged at its base, which was in the clouds, its length being about twice the width of the cylindrical part. It seemed to come down suddenly on to one of the hills of the park, and after touching the ground it rose rapidly in the same form as that in which it came down; from first to last it did not continue more than three minutes.

March 2nd, 1895.—Mr. Francis, Signal Master at Sydney, reports that at 6·10 a.m. on March 2nd, two very large water-spouts descended from a very dark massive cloud extending from south-east to north-east; it was about four miles off the coast and appeared to be taking up an immense quantity of water. The water-spouts were about a mile apart and travelling very slowly, the wind south and very light, at 6·25 a.m. both disappeared. At 6·35 a.m. another appeared in the same cloud and bearing due east of the Signal Station; it was much larger than either of those seen just before. It was about four miles from the coast, and the spout was vertical, volumes of water appeared to be going up it. The sea under it was all white foam, and the water seemed to

Digitized by Google

spray up for one hundred feet. It was a grand sight and the largest water-spout the observer had seen for a number of years. It was fully three hundred feet in length but not a great width, the rough sketches (*Plate 6*) will give some idea of it. It lasted half an hour.

The cloud was remarkably massive, dark and heavy below and like great white boulders above, it extended from north-east to south-east, and would be at least ten miles long; the water-spouts came down in the centre of it when about four miles off the land; the estimated length of this great water-spout was four hundred feet, and was nearly parallel throughout, (Fig. 1), forty to fifty feet in diameter above and about forty feet below. In Fig. 2 the top and base had enlarged and the water sprays about the base seemed to rise one hundred feet, indicating intense velocity of rotation, while a great roaring noise could be heard. In Fig. 3 it was much wider at the cloud; lower down it still maintained a width of forty feet, which could be seen through the spray down to the sea, while round it the water still sprayed, but not so much or so high. (Fig. 4) The tubular form disappeared for the moment and the outline was that of a long and narrow cone extending rather more than half way to the sea; the continuance of the vortex was shewn by the water spraying about twenty feet. (Fig. 5) Once more the water-spout re-formed like (Fig. 1) but with less intensity, the tube could again be seen from the cloud to the ocean, and about it spray was leaping up thirty feet. (Fig. 6) In this we see the dying water-spout, the vortex is still spraying up the water, and the tube is rolling up to the clouds. The Signal Master states that the two earlier water-spouts seen at this time and of which no sketches were taken, were something like Figs. 1 and 2. At 7·30 a.m. another water-spout appeared out of the same cloud in an east-north-east direction, distant five miles, and like the others lashed the water under it into foam; it lasted fifteen minutes and disappeared.

March 27, 1895.—Mr. Signal Master Francis reports that at 6·35 p.m. a water-spout appeared from a dark heavy looking cloud,

Digitized by Google

distant one mile to south-east, and travelling slowly towards the Signal Station; when within one quarter of a mile it disappeared suddenly. It was narrow, not more than eight or ten feet in diameter, but of a great length from cloud to water. It was the same size throughout, and it seemed to be taking up water in great quantities; soon after it disappeared a very heavy shower of rain fell (*Plate* 5). In Nos. 1 and 2 the water-spout was the same size about eight to ten feet in diameter throughout its length, towards the end it got thinner at the top, but its length was maintained until it broke.

May 16, 1898.—Mr. Pilot Newton at Eden saw the first water-spout at about 11 a.m., it was very long and dark and seemed to be quite perpendicular (*Plate* 3); when first seen it was eight miles off the land bearing east-north-east, it travelled rapidly to west-south-west until it got within three or four miles of the land and then disappeared. There were in all between fifteen and twenty water-spouts, after the first one they were much smaller, lighter in colour and not so straight. Some of them were very much curved towards the south and not one lasted for more than ten minutes. I estimated the length of the first one as a mile or thirty times the height of a clipper ship. I saw one break at the water and retreat to the clouds, another broke in the middle, the top rose up to the clouds and the lower half did not make any disturbance in the water when it fell.

June 30, 1898.—Captain Campbell Hepworth, Master of the R.M.S. *Aorangi* was on this date approaching Sydney at 8 a.m., when at a distance of eight miles east of Sydney Heads a water-spout was seen within one mile from the ship on the south side, the wind was light and fitful, shifting round the compass, at times blowing hard and then very light, weather thick with drizzling rain and occasionally short tropical showers. The water-spout travelled from south to north quite a short distance from the ship, and the splash made by the descending volume of water appeared like the effect produced by a continuous explosion as it struck the sea.

Digitized by Google

SOME PHYSICAL PROPERTIES OF NICKEL STEEL.

By W. H. WARREN, Wh.Sc., M. Inst. C.E., M. Am. Soc. C.E. Challis Professor of Engineering, and S. H. BARRACLOUGH, M.M.E., Assoc. M. Inst. C.E., Lecturer in Engineering, University of Sydney.

[*Read before the Royal Society of N. S. Wales, August 3, 1898.*]

1. *Introductory.*—Nickel steel has hitherto been chiefly used in the manufacture of armour plates, and, to a lesser extent, in forgings for certain important parts of machinery; but as the material becomes better known it is probable that its use will be very greatly extended. The increased cost of the steel caused by the addition of the nickel has been stated[1] to be about £3 per ton per unit of nickel, so that 3% would mean an addition to the cost of £9 per ton. If the demand for the material became greater, it would no doubt be produced at a much smaller cost, as was the case when mild steel superseded wrought iron for purposes of construction. The use of nickel in long span bridges would allow of a larger increase in the safe working stress and a consequent reduction in the dead weight which would be an off-set to the increased cost in such cases.

It appears that attention was first directed to the valuable properties of nickel steel by Mr. Riley of the Steel Company of Scotland in 1889, and in 1894 a length of shafting of nickel steel was constructed for the American liner *Paris*.

In June 1895 the Pennsylvania Steel Company made a heat of about four tons of open hearth nickel steel for the purpose of investigating its physical qualities when rolled into plates and bars. The results obtained in their experiments were lower than those from nickel steel produced in the ordinary way, in consequence of the small ingots obtained from the heat not allowing for a sufficient reduction in rolling.

[1] Engineering, Vol. LXIII., p. 589.

Digitized by Google

Last year an investigation was made on the properties of nickel and iron alloys by Prof. M. Rudeloff, Assistant Director of the Royal Prussian Testing Department, the alloys being melted in small quantities. The results are interesting as showing the influence of varying proportions of nickel on the physical properties of the alloys, and are briefly summarized as follows:—

Expansion by Heat.—The coefficient of expansion by heat was found to decrease with the increase in the percentage of nickel, but was greater with the 98% nickel alloy than with pure iron, thus

Pure iron...	1·000
Iron and 4% nickel	0·943
Iron and 16% nickel	0·891
Iron and 98% nickel	1·091

Tensile Strength.—The elastic limit, yield point, and ultimate breaking strength increase gradually by the addition of nickel up to 10%, after which a gradual decrease takes place up to 30%. With a further increase of nickel the elastic limit and yield point decrease still more, while the ultimate breaking load increases being greater with 60% than with 30% of nickel. The elongation decreases as the percentage of nickel increases, till at 16% it is almost zero; afterwards it increases up to 60% nickel and then again decreases. The elastic limit, yield point, and elongation of pure nickel are approximately 60% of those of pure iron, the breaking loads being about equal.

Compressive Strength.—The results obtained in compression are similar to those obtained in tension, but the resistance increases up to 16% nickel, and then decreases. Drop tests.—The results obtained in the drop test show an increase in strength up to with 16% nickel, and then a decrease until with 30% nickel it is the same as pure iron. Shearing tests gave similar results to those in tension.

While the foregoing summary may be taken to indicate relatively the results of varying proportions of nickel, the actual figures obtained in the various tests do not agree with those obtained

Digitized by Google

from similar alloys made on a large scale by experienced steel manufacturers.

2. *Tests of Nickel Steel manufactured in Great Britain.*—A valuable paper was contributed by Mr. William Beardmore to the Institution of Naval Architects in April 1897, which deals with tests of nickel steel and its application in steel forgings, more especially in propeller shafts, railway cranks, axles, crank pins, tyres, etc., also in plates for shipbuilding. The following table gives the results of Mr. Beardmore's tension tests on carbon and nickel steel showing the characteristic properties of the latter material relatively to carbon steel.

Comparison of the Yield Point and Breaking Strain of Nickel and Carbon Steel.

Thickness in inches.	Carbon Steel.		Nickel Steel.	
	Ultimate strength, tons per square inch	Yield point in tons per square inch.	Ultimate strength, tons per square inch.	Yield point in tons per square inch.
$\frac{3}{16}$	27·7	13·5	51·3	29·5
$\frac{3}{16}$	28·3	13·6	53·9	28·7
$\frac{1}{4}$	27·6	13·7	54·1	28·6
$\frac{1}{4}$	27·5	13·9	52·9	29·2
$\frac{3}{8}$	27·7	14·0	52·4	30·4
$\frac{3}{8}$	28·2	14·5	51·8	30·6
$\frac{1}{2}$	28·5	14·1	52·5	29·0
$\frac{1}{2}$	28·3	14·3	49·6	28·9
$\frac{3}{4}$	28·5	14·0	50·5	28·5
$\frac{3}{4}$	27·9	14·0	51·0	28·4
1	27·5	14·5	48·7	28·3

Here the yield point of nickel steel is equal to the ultimate strength of carbon steel.

Mr. Beardmore states that nickel steel can be bent, punched, drifted and welded successfully; he also gives some experiments by Mr. Whyte of Leith Docks on the behaviour of nickel steel, mild carbon steel, and wrought iron when exposed to the corrosive action of sea-water for one year, in which the loss of weight was as follows :—

Nickel steel 1·36%; Carbon steel 1·72%; Wrought iron 1·89%.

3. *Tests of nickel steel from F. Krupp.*—The firm of Fried. Krupp of Essen, manufacture substantially two kinds of nickel

Digitized by Google

steel, differing as regards the quantity of nickel contained therein, that is so say one has a comparatively small quantity of nickel amounting to from three to eight per cent., according to requirements, and the other contains a large quantity of nickel amounting to twenty-five per cent and more. The former is made of various degrees of hardness, as ingot nickel iron, mild, and medium hard, nickel steel; the texture is fine and fibrous, not merely in consequence of the nickel it contains, but of the careful and special treatment to which it is subjected while working in a hot state.

Nickel steel, especially the softer qualities, somewhat resembles the best wrought iron in regard to its fibrous texture, and if any damage is done to its surface such as a crack, or a sharp cut, it will not be rendered liable to sudden fracture like steel, but if subjected to excessive strain it will gradually yield like the best wrought iron. This important property was tested by subjecting axles of nickel and crucible steel to the drop test after first cutting them in the middle by means of a sharp turning tool to a certain depth, thus artificially damaging them. The crucible steel axle was fractured with the first blow falling from a height of 3·3 feet, the fracture being dense, finely granulated and serrated. The nickel steel axle required thirteen blows from heights of 3·3 to 21·3 feet to produce fracture, the axle deflecting 7·3 inches and gradually tearing away on the underside of the nick. A hollow nickel steel axle damaged in a similar manner sustained fifty-four blows, of which thirty-four took place from a height of thirty-six feet (that is with a momentum drop of 80,000 foot pounds).

The figures denoting the strength of the three axles were, after the test, ascertained to be as follows:—

	Tensile Strength per sq. in., pounds.	Elongation. Per cent.	Contraction. Per cent.	Elastic Limit. Pounds.
1. Crucible steel axle ...	82,800	20·8	57·3	46,600
2. Nickel steel axle	90,900	22·4	57·1	58,800
3. Hollow nickel steel axle ...	94,500	18·6	59·7	65,000

These results show the characteristic property of nickel steel, namely a high elastic limit.

Digitized by Google

In regard to nickel steel containing 25% of nickel and more.—This material has been proposed for those parts of engines and machinery which are specially liable to rust; it possesses great strength and ductility, but has a somewhat low limit of elasticity hence it is not so suitable for parts liable to great strains. It has been proposed for the construction of locomotive fire boxes, for which purpose it appears to be eminently suitable.

4. *Nickel Steel from the Bethlehem Iron Works.*—In the Bethlehem Iron Works, U.S.A., nickel steel forgings are made from fluid compressed, acid open-hearth steel, and are carefully annealed after forging. To get the best results it is necessary to use an ingot twice the diameter of the finished forging to be made from it, in order that the proper amount of work shall enter into the metal during the time of its reduction in size under the press. The ingot also should have from 30 to 50% extra metal at the top which is cut off, as only the lower portion of the ingot is solid and suitable for forging purposes. Whenever the form and size of the forgings will allow of such treatment, they should be made hollow by boring, and they may also be oil tempered. Presses should always be used in preference to hammers, and should produce a pressure penetrating to the centre and causing a flow throughout the mass.

The steel used in the field magnet rings of the large Niagara electric generators was made at the Bethlehem works. Each ring was forged in one piece without welding, from an ingot of nickel steel, 54 inches in diameter and 197 inches long. The ingot was cast solid and compressed by hydraulic pressure in the fluid state and during solidification. A hole was bored in the ingot which was subsequently expanded on a mandrel under a 14,000 ton hydraulic forging press. The material was tested after forging to obtain the physical qualities desired, the results being as follows :—

Sample No.	Tensile Strength pounds per sq. in.	Elastic Limit. pounds per sq. in.	Elongation on two inches, per cent.
1	82,915	53,560	27·05
2	81,110	47,230	25·75
3	82,140	49,280	22·50
Average	82,055	50,023	25·10

Digitized by Google

5. *Present Series of Tests.*—The authors considered that a more useful and exact knowledge of the properties of nickel steel could be obtained from a series of careful tests of material supplied by steel manufacturers of acknowledged reputation, as so much depends on the cautious treatment during the heating and forging, more especially with the alloys containing from 3 to 8% of nickel which are capable of being hardened. The following tests were made from specimens selected by one of the authors during a recent visit to the firm of Fried. Krupp of Essen, Germany. Three kinds of steel were tested which are denoted in the test sheets as follows:—

F—Mild,	containing	approximately	3%	nickel
T—Medium hard,	„	„	8	„
E—Non-rusting	„	„	25	„

The tests made by the authors were somewhat restricted in consequence of the limited number of specimens available, but they are sufficient to bring out clearly the physical properties of the material.

6. *Tensile Tests.*—These consisted in the first place in the determination of the elastic limit and coefficient of elasticity, the extensions being measured by Marten's mirror extensometer.[1] The test piece was afterwards divided between the reference points into spaces of one-quarter of an inch, and connected to the autographic apparatus and tested to destruction. The yield point recorded on the diagram is consequently higher than would have been the case if the test piece had not been previously strained in obtaining the true elastic limit. The results of these tests are shown in Tables I. to V., and in the summary Tables X. and XI.

The results of testing specimens cut from a railway axle made by Messrs. Vickers of Sheffield are also recorded, as showing the results of testing good steel of the ordinary kind, for the sake of comparing the results with those obtained from nickel steel.

[1] See Journ. Roy. Soc. Vol. xxxi., pp. 89–111.

Digitized by Google

7. *Compressive Tests.*—These consisted of the determination of the elastic limit and coefficient of elasticity as in the tensile tests, the compressions being observed with the Marten's mirror extensometer, the length of the specimens was ten inches, and diameter one inch; one set of readings was taken on a specimen two inches long. The compressive strength was determined by using cylinders one inch in diameter, and one and two inches long respectively. The compressive strength was taken as the yield point of the test piece. See Tables VI. to IX. and summary of results Table XII.

8. *Torsion Tests.*—These consisted of the determination of the value of f in the equation—

$$f = \frac{T}{0{\cdot}196\, d^3}$$

and the measurement of the total angle of twist in degrees. See Table XIII.

9. *Shearing Tests.*—These consisted of the determination of the load necessary to shear the specimen on two planes, *i.e.* in double shear; the results are summarized in Table XIV.

10. *Corrosion Tests.*—To obtain an indication of the relative values of the nickel steels as regards their resistance to corrosion, specimen discs of various irons and steels were prepared as shown in the accompanying table. These were first weighed and placed in a large beaker containing about a gallon of a weak[1] solution of sulphuric acid, which was maintained at a temperature of from 170° – 180° F. for twenty-four hours. The discs were then removed, thoroughly cleaned, and re-weighed.

It is necessary to draw attention to the elastic limits obtained both in tension and compression, as the results may appear low when compared with similar results obtained from autographic apparatus. The large multiplication obtained by the Marten's mirror apparatus shows a deviation from the straight line much earlier than could be seen in any autographic diagram. Careful

[1] One part by weight of strong sulphuric acid to one hundred parts of water.

Digitized by Google

tests of Vicker's axle-steel made with Kennedy's extensometer gave an elastic limit of sixteen tons per squre inch, whereas the Marten's apparatus gave 14·5 tons per square inch. Until a standard method for determining this point is agreed upon, it will always be difficult to compare the results obtained by experimenters using different extensometers.

Table I.

Determination of the elastic limit and coefficient of elasticity in tension of nickel steel "F" (mild).

Length upon which elongations were measured = 150 mm. (6 in.)
Diameter = 0·6085" Area = 0·2908 square inches.

Load in 1,000 lbs.	Readings in $\frac{1}{5,000}$ mm.		Mean Extension[1] in $\frac{1}{10,000}$ mm.	Differences per 1,000 lbs.	
	Top.	Bottom.			
0	3·12	2·19	5 31		
				1·56	
2·5	4·70	4·50	9·20		
				1·70	
3	5·10	4·95	10·05		
				1·86	
4	6·00	5·91	11·91		
				1·81	
5	6·9)	6·82	13·72		
				1·89	
6	7·82	7·79	15·61		
				1·82	
7	8·75	8·70	17·43		
				1·87	
8	9·66	9·64	19·30		
				1·85	
9	10·58	10·57	21·15		
				1·87	
10	11·51	11·51	23·02		
				1·83	
11	12·44	12·41	24·85		
				1·93	
12	13·41	13·37	26·78		† Limit of
				2·04	Elasticity
13	14·43	14·39	28·82		
				2·60	
14	15·70	15·78	31·42		

† Limit of Elasticity = 12,500 lbs. or $\frac{12,500}{0·2908}$ = 43,000 lbs. per sq. in. (19·2 tons)

Coefficient of Elasticity = 27,7300,000 lbs. per sq. in.
= 12,375 tons per sq. in.

[1] Obtained by adding the figures in the preceding two columns.

Digitized by Google

Table II.

Determination of the elastic limit and coefficient of elasticity in tension of nickel steel "T" (medium).

Length upon which the elongations were measured = 150 mm. (6 in.)
Diameter = 0·609" Area = 0·2911 square inches.

Load in 1,000 lbs.	Readings in $\frac{1}{5,000}$ mm		Mean Extension in $\frac{1}{10,000}$ mm.	Differences per 1,000 lbs.	
	Top.	Bottom.			
0	0·00	7·00	7·00		
				1·13	
1	0·48	7·65	8·13		
				1·87	
2	1·30	8·70	10·00		
				1·91	
3	2·18	9·73	11·91		
				1·90	
4	3·10	10·70	13·81		
				1·92	
5	4·08	11·70	15·73		
				1·74	
6	4·85	12·62	17·47		
				1·87	
7	5·78	13·56	19·34		
				1·88	
8	6·80	14·42	21·22		
				1·87	
9	7·79	15·30	23·09		
				1·89	
10	8·78	16·20	24·98		
				1·64	
11	9·62	17·00	26·62		
				1·88	
12	10·60	17·90	28·50		
				1·80	
13	11·52	18·78	30·30		
				1·90	
14	12·50	19·70	32·20		
				1·90	
15	13·48	20·62	34·10		† Limit of Elasticity
				2·16	
16	14·48	21·78	36·26		
				2·11	
17	15·62	22·75	38·37		
				2·19	
18	16·66	23·90	40·56		
				2·46	
19	18·00	25·20	43·02		
				4·23	
20	20·00	27·25	47·25		

† Limit of Elasticity = 15,500 lbs. or $\frac{15,500}{0·2911}$ = 53,200 lbs. per sq. in. (23·75 tons)

Coefficient of Elasticity = 27,120,000 lbs. per sq. in.
= 12,110 tons per sq. in.

Digitized by Google

Table III.

Determination of the elastic limit and coefficient of elasticity in tension of nickel steel "E" (non-rusting).

Length upon which the elongations were measured = 150 mm. (6 in.)

Diameter = 0·6075" Area = 0·2899 square inches.

Load in 1,000 lbs.	Readings in $\frac{1}{5,000}$ mm.		Mean Extension in $\frac{1}{10,000}$ mm.	Differences per 1,000 lbs.	
	Top.	Bottom.			
0	0·00	5·00	5·00		
				0·08	
1	−0·02	5·10	5·08		
				2·02	
2	+0·72	6·38	7·10		
				2·16	
3	1·76	7·50	9·26		
				2·04	
4	2·82	8·48	11·30		
				2·08	
5	3·92	9·46	13·38		
				2·13	
6	5·08	10·43	15·51		
				2·11	
7	6·22	11·40	17·62		
				2·11	
8	7·34	12·39	19·73		
				2·26	† Limit of Elasticity
9	8·52	13·47	21·99		
				2·78	
10	9·89	14·88	24·77		
				4·03	
11	11·85	16·95	28·80		

† Limit of Elasticity = 8,500 lbs. or $\frac{8,500}{\cdot 2899}$ = 29,350 lbs. per sq. in. (13·1 tons)

Coefficient of Elasticity = 26,340,000 lbs. per sq. in.
= 11,760 tons per sq. in.

Digitized by Google

Table IV.

Determination of elastic limit and coefficient of elasticity of Vicker's axle steel No. "5" in tension.

Length upon which extensions were measured = 150 mm. (6 in.)

Diameter = 0·610" Area = 0·2922 square inches.

Load in 1,000 lbs.	Readings in $\frac{1}{5,000}$ mm.		Mean Extension in $\frac{1}{10,000}$ mm.	Differences per 1,000 lbs.	
	Top.	Bottom.			
1	1·39	7·52	8·91		
				1·75	
2	2·15	8·51	10·66		
				1·83	
3	2·99	9·50	12·49		
				1·81	
4	3·89	10·41	14·30		
				1·78	
5	4·77	11·31	16·08		
				1·82	
6	5·66	12·24	17·90		
				1·73	
7	6·51	13·12	19·63		
				1·78	
8	7·39	14·03	21·42		
				1·84	
9	8·29	14·97	23·26		
				1·87	† Limit of Elasticity
10	9·20	15·93	25·13		
				1·86	
11	10·09	16·90	26·99		
				2·74	
11·5	10·78	17·58	28·36		

† Limit of Elasticity = 9,500 lbs. or $\frac{9,500}{0·2922}$ = 32,500 lbs. per sq. in. (14·5 tons)

Coefficient of Elasticity = 28,680,000 lbs. per sq. in.

= 12,805 tons per sq. in.

Digitized by Google

Table V.

Determination of the elastic limit and coefficient of elasticity in tension of Vicker's axle steel No. "6."

Length upon which elongations were measured = 150 mm. (6 in.)
Diameter = 0·610″ Area = 0·2922 square inches.

Load in 1,000 lbs.	Readings in $\frac{1}{5,000}$ mm.		Mean Extension in $\frac{1}{10,000}$ mm.	Differences per 1,000 lbs.	
	Top.	Bottom.			
2·5	2·41	7·69	10·10		
				1·66	
3	2·79	8·14	10·93		
				1·78	
4	3·60	9·11	12·71		
				1·68	
5	4·40	9·99	14·39		
				1·75	
6	5·25	10·89	16·14		
				1·74	
7	6·10	11·78	17·88		
				1·75	
8	6·97	12·66	19·63		
				1·84	
9	7·87	13·60	21·47		
				1·92	† Limit of Elasticity
10	8·82	14·57	23·39		
				2·61	
11	10·10	15·90	26·00		

† Limit of Elasticity = 9,500 lbs. or $\frac{9,500}{0·2922}$ = 32,500 lbs. per sq. in. (14·5 tons)

Coefficient of Elasticity = 29,000,000 lbs. per sq. in.
= 12,950 tons per sq. in.

Table VI.

Determination of elastic limit and coefficient of elasticity in compression of nickel steel "F" (mild).

Length upon which contractions were measured = 10″
Diameter = 1″ Area = 0·7854 square inches.

Load in 1,000 lbs.	Readings in $\frac{1}{5,000}$ mm.		Mean Compression in $\frac{1}{10,000}$ mm.	Differences per 1,000 lbs.
	Top.	Bottom.		
1	0·00	4·00	4·00	
				1·01
2·5	1·20	4·32	5·52	
				0·46
3	1·27	4·48	5·75	
				0·85
4	1·81	4·79	6·60	
				0·86
5	2·35	5·11	7·46	
				0·93
6	2·90	5·49	8·39	
				0·85
7	3·39	5·85	9·24	
				0·86
8	3·85	6·25	10·10	
				0·89

Digitized by Google

Table VI.—*continued.*

Load in 1,000 lbs.	Readings in $\frac{1}{5,000}$ mm.		Mean Compression in $\frac{1}{10,000}$ mm.	Differences per 1,000 lbs.	
	Top.	Bottom.			
9	4·30	6·69	10·99		
				0·91	
10	4·79	7·11	11·90		
				0·89	
11	5·29	7·54	12 79		
				0·91	
12	5·69	8·01	13·70		
				0·86	
13	6·11	8 45	14 56		
				0·87	
14	6·55	8 89	15·43		
				0·90	
15	6·98	9 35	16 33		
				0·87	
16	7·40	9·80	17·20		
				0 90	
17	7·80	10 30	18·10		
				0·86	
18	8·18	10 78	18·96		
				0·92	
19	8·60	11 28	19·88		
				0·86	
20	8·98	11·76	20 74		
				0·88	
21	9 37	12·25	21·62		
				0·90	
22	9·75	12·77	22·52		
				0·91	
23	10·13	13·29	23·43		
				0·88	
24	10·51	13·80	24·31		
				0·89	
25	10·88	14·25	25·20		
				0·80	
26	11·30	14·70	26·00		
				0·87	
27	11·67	15·20	26·87		† Limit of Elasticity
				0 99	
28	12·08	15·78	27·86		
				0·94	
29	12·40	16·40	28·80		
				0·92	
30	12·70	16·98	29·72		
				1·00	
31	13·15	17·57	30·72		
				1·05	
32	13·55	18·22	31·77		
				1·07	
33	14·02	18·92	32·94		
				1·30	
34	14·60	19·64	34·24		

† Limit of Elasticity = 27,000 lbs. or $\frac{27,000}{0·7854}$ = 34,400 lbs. per sq. in. (15·35 tons)

Coefficient of Elasticity = 28,770,000 lbs. per sq. in.
= 12,850 tons per sq. inch.

Digitized by Google

Table VII.

Determination of elastic limit and coefficient of elasticity in compression of nickel steel "F."

Length upon which contractions were measured = 2".

Diameter = 1" Area = 0·7854 square inches.

Load in 1,000 lbs.	Readings in $\frac{1}{5,000}$ mm.		Mean Compression in $\frac{1}{10,000}$ mm.	Differences per 2,000 lbs.	
	Top.	Bottom.			
5	0·40	4 39	4·79		
				0·34	
6	0·55	4·41	4·96		
				0·32	
8	0·69	4·59	5·28		
				0·26	
10	0·85	4·69	5·54		
				0·29	
12	1·02	4·81	5·83		
				0·33	
14	1·19	4·97	6·16		
				0·30	
16	1·34	5·12	6·46		
				0·35	
18	1·50	5·31	6·81		
				0·36	
20	1·67	5 50	7·17		
				0·35	
22	1·82	5·70	7·52		
				0·39	† Limit of Elasticity
24	2·01	5·90	7·91		
				0·46	
26	2·12	6·15	8·37		
				0·53	
28	2·48	6·42	8·90		
				0·67	
30	2 85	6·72	9·57		
				0·44	
32	3·02	6 99	10·01		
				0·79	
34	3 40	7·40	10·80		

† Limit of Elasticity = 23,000 lbs. or $\frac{23.000}{0·7854}$ = 30,580 lbs. per sq. in. (13·1 tons)

Coefficient of Elasticity = 28,140,000 lbs. per sq. in.
= 12,560 tons per sq. in.

Digitized by Google

Table VIII.

Determination of the elastic limit and coefficient of elasticity in compression of nickel steel "T."

Length upon which contractions were measured = 10″

Diameter = 1″ Area = 0·7854.

Load in 1,000 lbs.	Readings in $\frac{1}{5,000}$ mm.		Mean Compression in $\frac{1}{10,000}$ mm.	Differences per 2,000 lbs.	
	Top.	Bottom.			
5	2·10	5·74	7·84		
				1·77	
7	3·10	6·51	9·61		
				1·69	
9	4·01	7·29	11·30		
				1·75	
11	4·96	8·09	13·05		
				1·74	
13	5·89	8·90	14·79		
				1·76	
15	6·83	9·72	16·55		
				1·79	
17	7·76	10·58	18·34		
				1·72	
19	8·61	11·45	20·06		
				1·78	
21	9·52	12·32	21·84		
				1·76	
23	10·41	13·19	23·60		† Limit of Elasticity
				1·80	
25	11·31	14·09	25·40		
				1·78	
27	12·18	15·00	27·18		
				1·80	
29	13·08	15·90	28·98		
				1·82	
31	14·00	16·80	30·80		
				1·83	
33	14·91	17·72	32·63		
				1·92	
35	15·88	18·67	34·55		
				1·86	
37	16·81	19·60	36·41		
				1·93	
39	17·79	20·55	38·34		
				2·02	
41	18·76	21·60	40·36		
				2·18	
43	19·85	22·69	42·54		
				2·18	
45	20·96	23·76	44·72		

† Limit of Elasticity = 23000 lbs. or $\frac{23,000}{0·7854}$ = 29,300 lbs. per sq. in. (13·1 tons)

Coefficient of Elasticity = 28,170,000 lbs. per sq. in.
= 12,570 tons per sq. in.

Digitized by Google

Table IX.

Determination of elastic limit and coefficient of elasticity in compression of nickel steel "E."

Length upon which contractions were measured = 10″

Diameter = 1″ Area = 0·7854 square inches.

Load in 1,000 lbs.	Readings in $\frac{1}{5,000}$ mm.		Mean Compression in $\frac{1}{10,000}$ mm.	Differences per 1,000 lbs.	
	Top.	Bottom.			
1	0·00	0·00	0·00		
				1·00	
2	0·50	0·50	1·00		
				0·98	
3	0·98	1·00	1·98		
				1·02	
4	1·50	1·50	3·00		
				1·00	
5	2·00	2·00	4·00		
				1·00	
6	2·50	2·50	5·00		
				1·00	
7	3·00	3·00	6·00		
				1·00	
8	3·50	3·50	7·00		
				1·00	
9	3·98	4·02	8·00		
				0·92	
10	4·40	4·52	8·92		
				0·94	
11	4·86	5·00	9·86		
				1·01	
12	5·35	5·52	10·87		
				1·02	
13	5·85	6·04	11·89		
				0·95	
14	6·32	6·52	12·84		
				0·98	
15	6·80	7·02	13·82		
				0·99	
16	7·30	7·51	14·81		
				1·00	
17	7·80	8·01	15·81		
				0·98	
18	8·29	8·50	16·79		
				1·01	
19	8·80	9·00	17·80		
				1·00	
20	9·27	9·53	18·80		
				0·96	
21	9·73	10·03	19·76		† Limit of
				1·06	Elasticity
22	10·26	10·56	20·82		
				1·04	
23	10·78	11·08	21·86		
				1·08	
24	11·30	11·64	22·94		
				1·03	Specimen was
25	11·81	12·16	23·97		permanently bent

† Limit of Elasticity = 21,000 lbs. or $\frac{21,000}{0·7854}$ = 26,750 lbs. per sq. in. (11·99 tons)

Coefficient of Elasticity = 25,460,000 lbs. per sq. in.
= 11,360

Digitized by Google

Table X.—Summary of Results obtained in Tensile Tests of Nickel Steel.

Test No.	Description.	Original dimensions		Stress in Pounds.		Stress in tons per sq. in.	Limit of Elasticity in tons per sq. in.	Yield point in tons per sq. in.	Ratio of Limit to Break per centum.	Contracted dimensions.		Contraction of Area, per cent.	Elongations measured after fracture.		Local Elongations, in.	General Elongation, per cent.	Coefficient of Quality.	Coefficient of Elasticity in tons per sq. in.
		Diameter in inches.	Area in sq. ins.	Per sq. in.	Total.					Diameter in inches.	Area in sq. ins.		on 6 ins.	on 3 ins.				
F	Mild ...	0·608	0·2908	21400	73600	32·88	19·2	23·05	58	0·319	0 0806	72·3	1·75	1·08	0·41	22·3	7·3	12375
T	Medium ...	0·609	0·2911	33250	114250	51·40	23·75	36·00	46	0·460	0·1662	43·0	1·30	0·80	0·30	16·6	8·5	12110
E	Non-rusting	0·607	0·2705	28700	106100	47·88	13·10	23·75	27	0·321	0 0811	70·0	2·35	1·35	0·35	33·3	15·7	11760

Note.—The yield points were raised in consequence of the elastic limit having been first determined by Marten's mirror apparatus.

Table XI.—Summary of Results obtained in Tensile Tests of Vicker's Steel.

5	Vicker's axle steel, test pieces cut from the same axle.	0·610	0·2922	22250	76200	34·15	14·5	25·22	42	0·408	0·1261	56·5	1·30	0·85	0·40	15·0	5·1	12805
6		0·610	0·2922	22500	77000	34·40	14·5	22·48	45	0·406	0·1260	56·6	1·23 on 10 in.	0·80 on 5 in.	0·37	14·0	4·8	12950
2a		1·125	0·9941	76700	77153	34·40	14·5	20·85	45	0·770	0·4656	53·16	2·10	1·46	0 82	12·8	4·4	
1a		1·125	0·9941	75500	75940	33·94	14·5	20·70	42	0·760	0·4458	55·16	2·53	1·59	0·65	18·8	6·3	
1b		0·840	0·5541	42250	76240	34·03	14·5	...	42	0·565	0·2507	54·75	2·30	1·41	0·56	17·8	6 0	
2b		0·840	0·5541	42250	76240	34·03	14·5	...	42	0·567	0·2525	54·44	1·72	1·13	0·46	11·8	4·0	

Note.—The yield points in table were raised in consequence of the elastic limit having been first determined by means of Marten's extensometer. In Nos. 5 and 6 the true yield point, from extensometer readings, was 18·4 tons per square inch

Digitized by Google

Table XII.

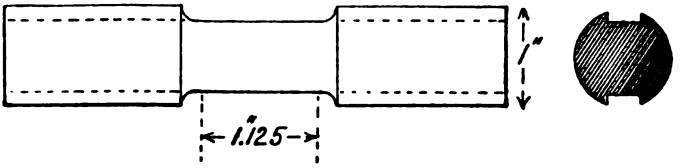
Summary of Results obtained in Compressive Tests of Nickel Steel.

Diameter of test piece 1 inch, area 0·7854.

Reference Letter.	Description.	Length of test piece in inches.	Elastic limit in tons per square inch.	Coefficient of elasticity in tons per square inch.	Compressive strength in tons per square inch.	Maximum load applied in tons per square inch.	Plastic compression with maximum load per lineal inch.
		10·00	14·50	12705			
F	Mild ...	2·00	...	...	24·2	44·5	0·11
		1·52	...	...	...	63·6	0·26
		10·00	13·10	12570			
T	Medium ...	2·00	...	...	42·0	69	0·137
		1·48	...	...	...	73	0·172
		10·00	11 99	11360			
E	Non-rusting	2·00	...	...	25·3	55·5	0·115
		1·49	...	...	25·3	70·0	0·175

Table XIII.

Torsional Tests of Nickel Steel.

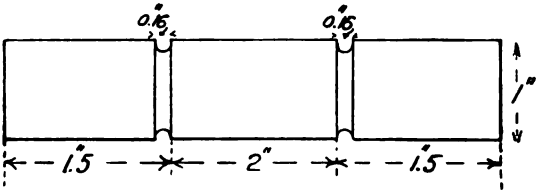


Reference Letter.	Diameter of test piece in inches.	Length of test piece in inches.	Total twisting moment in inch pounds.	Value of f in equation $f = \frac{T}{0{\cdot}196d^3}$ in pounds per sq. in.	Total angle of twist in degrees.	Length of test piece after fracture in inches.	Percentage of elongation or shortening.
E	0·715	1·125	10931·3	152578	900	1·140	+1·3
F	0·714	1·125	6809·6	95448	405	1·120	- 0·44
T	0·714	1·125	8960·0	125591	180	1·125	0

Digitized by Google

Table XIV.

Shearing Tests.



Reference Letter.	Diameter in inches.	Area in square ins.	Total load in double shear in pounds.	Double shear per square in. in pounds.	Single shear per square inch.
E	0·780	0·4778	99456	208096	104048
F	0·783	0·4815	71568	148624	74312
T	0·783	0·4815	95200	197568	98784

Table XV.

Description of Specimen	Original Weight, grains.	Final Weight grains.	Loss in Weight.	Loss in Weight per cent.
Nickel Steel, E (non-rusting) ...	No loss	could be	detected.	
„ „ F (mild)	743·0	731·8	11·2	1·51
Krupp, Essen, K	755·1	736·4	18·7	2·48
„ $\frac{H\,E}{K}$ (special ingot iron)	747·5	726 8	20·7	2·77
Dalziell's Steel	738·5	715·9	22·6	3·06
Patent Shaft and Axle Co. ..	738·3	705·3	33·0	4·47
Lowmoor Boiler Plate	731·0	694·0	37·0	5·06
Monkbridge Boiler Plate	733·2	690·2	43·0	5·86
Nickel Steel T (medium)	754·5	705·0	49·5	6·56

Digitized by Google

KEY to TRIBES and GENERA of MELANOSPERMEÆ.

(Olive-green Seaweeds.)

By Richard A. Bastow, Fitzroy, Victoria.

(Communicated by J. H. Maiden, F.L.S.)

[With Plate I.]

[*Read before the Royal Society of N. S. Wales, September 7, 1898.*]

The study of Seaweeds found in the seas surrounding the Australian Continent and adjacent islands is, at the present time, beset with many difficulties. However invigorating and pleasant it may be to stroll along the beach on a sunny day, and to collect some beautiful species as they float to one's feet, it is unsatisfactory to find that there are few books accessible in the libraries whereby the plants may be identified. There does not appear to be a complete copy of Harvey's "Nereis Australis," either in Victoria, South Australia, or West Australia, at any rate the writer has searched the public libraries in those three colonies in vain for that work, unless the book which contains fifty plates only is to be considered the complete work. Agardh's and Kuetzing's works are in Latin and are therefore not as useful as if they were in English. Consequently, it was thought advisable by the writer (who has collected a fairly complete set of notes on the subject from authorities far and wide), to construct a key whereby the young student may find information in a very much easier manner than hitherto possible. The result is the accompanying key which presents the salient points of the genera of the Melanospermeæ on one sheet; it must be borne in mind however, that Melanospermeæ are only one of the three great divisions of Seaweeds. The Florideæ or Red Seaweeds, and the Chlorospermeæ or Grass-green Seaweeds are not included in this key. The Melanospermeæ are usually olive-brown or olive-green in colour, and sometimes almost black, many of them being very large and coarse. The

Digitized by Google

fruit is on the surface of the frond, or in proper cavities in its substance, and consists of four-parted spores enclosed in a hyaline membrane, oblong antheridia terminating jointed filaments, and buds or leaflets capable of becoming new plants.

The key is intended to assist the collector in identifying a genus; it may assist him in finding the species as well, and to use it the plants must of course first be collected, then dried, and afterwards sections must be cut. Let us therefore imagine that we are at the sea side, the waves are rolling in majestically, yet there are a few rocks uncovered by the tide, to these we hasten, and find in a dark corner of a little pool a small tuft as though it had been eaten down by fishes; it is nothing to look at by unassisted vision, but an ordinary pocket lens displays its irregular symmetry and exquisite areolation. It is *Amansia marchantioides*, one of the Florideæ, we see that by the faint pink tinge, consequently it is not on our key. Almost covering the bottom of the pool are some Algæ resembling lettuce plants; a few transparent shrimps dart in and out from the fronds, which are *Ulva;* they are light grass-green and belong to the Chlorospermeæ, we therefore place them aside, for they also are not in the key. Laying across one of the tufts of *Ulva* is a curious string of beads, washed into the pool and left there by the ebbing tide; these are Melanospermeæ for they are olive-green, and we find that they are *Hormosira Banksia*, for they are figured on the key at No. 15 square. We will look closer at this plant immediately. On the beach close by we collect a frond of thin texture, about half an inch wide, dichotomously divided, and with a midrib, this is also light olive-green; we glance at the key and find it is figured on square 17, we also notice that it is covered with minute prominences as shewn on the drawing; it is *Myriodesma quercifolia*. Here is a mass of *Ecklonia* and *Sargassum*, as much as a man can lift, they are figured on the key at Fig. 29, and Figs. 1.1 to 1.12. Making a mental note of these, we notice a few pellicles of gelatine on the *Sargassum*, about as large as peas. They are figured at the 48th square and are called *Leathesia*. These we take home and submit to the

Digitized by Google

drying process, just as we should with any ordinary plant, that is, after they have been washed and properly displayed.

The washing and displaying should be done by means of two large white flat dishes, in the one the specimens should be washed, pruned, and freed from parasites; they should then be introduced into the other dish singly. When the specimen is floated in the second dish, a neatly cut square of white cartridge paper is to be placed under it, then, with some pointed instrument, the fronds arranged as carefully and naturally as possible; it must then be gently withdrawn from the water, a piece of muslin placed over it to prevent it sticking to the drying paper, and the whole submitted to slight pressure. The specimens will generally be dry in a day or two, and should have the date and locality written on them at once.

We will now suppose that the plants are dry or nearly dry, and we proceed to examine the frond and fruit. We will take the *Hormosira* first. The beads of which the plant is composed are now flattened, and may be cut with a pair of draper's scissors; these scissors are broad at the points and therefore answer our purpose best. Provide a glass slip with a drop of water on it on a sheet of white paper, then take one of the beads between the thumb and forefinger of the left hand, hold it directly over the drop of water on the slip, and cut it into as fine shreds as possible, taking care to use the left thumb nail as a fence or stay for the scissors blade. Cut about a score of sections as small as possible, *i.e.*, thin, then look at them through the microscope, there are sure to be four or five beautifully thin sections already swelling out and showing the medullary and cortical layers of the frond, and most probably there will also be found some sections of the fruit or conceptacle, as shown in Fig. 15, an excellent specimen of Fucoid fruit. If a quarter inch objective be now used, the spores will be shown as figured. Now turn to the generic description at No. 15. We there read that the frond of *Hormosira* is moniliform, that is, beaded; that the internodes are inflated; so these are, very much; also that it has a distinct stem and branches.

Digitized by Google

Then follows a reference to Hooker's "Handbook of the New Zealand Flora," at page 652, where much further information concerning the plant can be obtained.

Myriodesma quercifolia can be examined exactly in the same manner, or easier still by placing the point of a lancet or sharp knife against one of the prominences, thus lifting the cuticle as shown at Fig. 17. It can then be seen as an opaque object, of course with the aid of a good bull's eye condenser. The gelatinous pellicle, *Leathesia*, must be cut with the scissors as before directed, and immediately the surface of the water on the slip will be filled with spores and filaments as shown at Fig. 48. It will be noticed by the key that this plant belongs to the tribe Chordarieæ, whilst the two previously examined belong to the Fucæ.

It is a great help to have the series of genera before one, for a tremendous amount of time is consumed in turning over leaf after leaf of many volumes in the sometimes vain hope of finding the plant illustrated, especially is this the case in regard to Harvey's Phycologia Australis, a truly magnificent work, but not paged.

It is necessary to inform the reader that the classification is according to Dr. Sonder's catalogue, contained as a supplement in Vol. XI. of Baron von Mueller's *Fragmentæ Phytographiæ Australiæ*. The numbers of the genera are the same in the key as they are in the catalogue, so that reference can be readily made. Some of the genera have been divided in recent years, but under the old names most of them will be found in the catalogue. The illustrations are made in every case from specimens in the National Herbarium, Melbourne; some were mere fragments, yet they were sufficient for dissection and section cutting required for the figures; and, I must here express my thanks to the authorities at the Herbarium for specimens not otherwise obtainable.

The following books have been used in the compilation of the key:—Harvey's—Nereis Australis, Parts 1, 2, with plates 1 - 50; Phycologia Britannica; Phycologia Australis; Nereis Borealis Americanus; Hooker's—Antarctic, New Zealand and Tasmanian

Digitized by Google

Floras; Handbook to Flora of New Zealand; Agardh's Species Genera et Ordines Algarum; Kuetzing's Species Algarum; Rabenhorst's Species Algarum; D'Urville's Voyage Astrolabe; Murray's Introduction to Study of Seaweeds; London Journal of Botany; American Science Nat.; De Toni's Sylloge Algarum.

ÉTUDE SUR LES DIALECTES DE LA NOUVELLE-CALÉDONIE.

Par JULIEN BERNIER.

(Communicated by C. Hedley, F.L.S.)

[*Read before the Royal Society of N. S. Wales, September 7, 1898.*]

Multiplicité des dialectes Neo-Calédoniens.

On compte en général une vingtaine de dialectes employés par les indigènes de la Nouvelle-Calédonie.

Les premiers Européens établis dans le pays, ont été frappés de cette confusion qui ressemble un peu à celle de la Tour de Babel; mais il suffit de quelque attention pour reconnaître que cette diversité n' est qu' apparente, et que tous ces dialectes, au fond, se rattachent à une souche commune. On a cherché à expliquer ce phénomène de différentes manières, notamment par les migrations,[1] qui ont, en effet, introduit dans le pays quelques mots d' origine étrangère, comme le polynésien "*ika*," (poisson) qui devient à Wagap "*ikoua*"; "*vaka*," (pirogue) qu'on retrouve dans "*ti-vaka*," (rivière-pirogues), deux mots essentiellement polynésiens.

[1] On retrouve encore aujourd'hui des traces certaines de ces migrations, dans le Nord et aux Loyalty. Elles sont également attestées par l' existence de deux langues dans un grand nombre de tribus: la langue du peuple, c'est-à-dire des vaincus, et la langue des Chefs, c'est-à-dire des vainqueurs.

Digitized by Google

Cependant, ces apports de mots étrangers, si importants qu 'ils aient pu être, ne sauraient expliquer d' une façon suffisante cette multiplicité de dialectes qu'on remarque, non seulement chez les Neó-Calédoniens, mais chez toutes les peuplades de la même race et on peut dire, d'une façon générale, chez toutes les races primitives. Nous sommes ici en présence, non pas d'un fait accidentel, mais d'un phénomène anthropologique, si je puis m'exprimer ainsi, et dont il faut chercher la cause dans la nature même de l' homme.

Cette cause, c'est l'extrême mobilité du son, c'est-à-dire de la parole, chez toutes ces races. Le langage, qui n'est qu'un agencement de sons, évolue indéfiniment, même chez les nations les plus civilisées. Le français que nous parlons aujourd 'hui, ne ressemble pas à celui que parlaient nos pères, du temps de Saint Louis, et l'anglais moderne n'est plus le même que celui du roi Richard. Les langues se sont modifiées et se modifient tous les jours.

A plus forte raison en est-il de même pour des races qui n'ont ni l'écriture, ni aucun autre moyen de fixer leur langue, et dont l'intelligence ne conçoit même pas les différences qui existent pour nous, entre certains sons. La pensée étant obscure, la parole, qui n'est que la forme de la pensée, est elle-même incertaine et confuse. Les racines n'ont aucune fixité.

Le Révd. Macdonald,[1] missionnaire à Efate, (Nouvelles Hébrides), dit que les indigènes de cette île prononcent indifféremment: "*bo*," "*fo*," "*mo*," "*uo*," "*o*," pour exprimer le même mot. Cette observation, prise sur le vif par un homme qui connaît parfaitement la langue du pays, peut s'appliquer à toutes les races de l'Océanie.

A Tahiti, "*va*," (eau) devient "*vaï*," "*pape*," "*roï*." A Madagascar, "*afo*," (feu), devient "*anrou*," et "*androu*." Le Maori de la Nouvelle Zélande dit: "*waka*" (faire); à Tonga, "*faka*"; à Madagascar, "*maka*," "*mang*," "*man*," pour "*maka*."

En Nouvelle Calédonie, "*wa*," (eau), devient "*Wen*," "*Kwen*," "*Kwa*," "*po*," "*fo*," "*foa*," "*moua*." La forme redoublée "*wawe*,"

[1] The Asiatic Origin of the Oceanic Languages, Melbourne 1894.

Digitized by Google

devient "*ya we*," "*awe*," "*ewe*," "*dia we*," "*tia re.*" "*Wen*," (bouche) devient "*mouen*," "*pouen*," etc., etc.

En d'autres termes, c'est l'instabilité de la parole qui amène la diversité des dialectes, et cette instabilité provient elle-même du développement insuffisant de la pensée. Des hommes qui ne savent pas distinguer le bras de la main, le pied de la jambe, pour qui les cheveux et les plumes ne sont pas autre chose que des feuilles et des herbes, ne sauraient saisir les nuances qui existent entre un son et un autre, pas plus qu'ils ne saisissent les nuances qui existent entre les couleurs. Il y a là une règle fondamentale, une loi dont on doit absolument tenir compte, si l'on veut pénétrer le secret de la formation des mots dans les langues primitives.

Groupement des Dialectes—Premier Groupe, ou groupe Sud.

Si l'on examine dans leur ensemble les dialectes de la Nouvelle-Calédonie, on remarque qu'ils peuvent se rattacher à trois groupes principaux.

En commençant par le Sud, nous avons un premier groupe qui comprend: l'île des Pins, Goro, Touaourou, l'île Wen, la Dumbea, Saint-Vincent, sur la côte Ouest; Yate et Ounia sur la côte Est. La limite géographique dans laquelle cette langue est employée, paraît être la Tontouta d'une part, et Port-Bouquet de l'autre. Toutes les tribus de cette région s'expriment de la même manière, sauf quelques différences locales de prononciation qui ne les empêchent pas de se comprendre.

Exemple:

	Ile de Pins.	Goro.	Touaourou.	Unia.	Wen.
Arbre	*N gohe*	*N-gwe*	*N-goeu*	*N-goeu*	*N-goe*
Flèche	*Pata*	*Pata*	*Pata*	*Pata*	*Pata*
Blanc	*Baa*	*M baa*	*M boua*	*M boua*	*Poua*
Casse-tête	*Moua*	*Moua*	*Moua*	*Moua*	*Moua*
Couteau	*Nou*	*Nou*	*Nou*	*Nou*	*Nou*
Mourir	*Mê*	*Mere*	*Moure*	*Mere*	*Mere*
Main	*Me*	*Me*	*Me*	*Me*	*Me*
Mère	*Nene*	*Nene*	*Gnià*	*Gnià*	*Nene*
Feu	*Tate*	*Tati*	*Tati*	*Tati*	*Tati*

Digitized by Google

Groupe Central.

Le deuxième groupe, que j' appellerai groupe central, comprend toute la région moyenne de l'Ile; pour la côte Est: Thio, Nakéty, Canala, Houaïlou et Ponerihouen. La limite sur ce point est le Cap Baye. Pour la côte Ouest: la Wenghi, Bouloupari, La Foa, Moindou, Bourail, Poya.

Bien que ce groupe présente moins d'homogénéité que le premier et que souvent les indigènes ne se comprennent pas entre eux d'une tribu à une autre, on peut remarquer, par une courte analyse, que les divers dialectes qui le composent ont entre eux des liens étroits. A Canala, par exemple, l'eau s'appelle "*Kwe*"; à Houaïlou, "*Cha*"; à la Foa, "*aloua.*" Il n' y a, en apparence, aucun rapport entre ces trois termes ; mais si l'on se rappelle ce qui vient d' être dit au sujet de l' extrême mobilité du son dans les langues primitives, et si l' on suit, dans ces langues, les différentes manières de désigner l'eau, on voit que "*kwe*" est pour "*kwa,*" qui n'est qu'un semi-durcissement de "*wa.*" De son côté "*wa*" devient "*ka*" qui fait "*cha*" par aspiration. Quant à "*aloua,*" il a pour forme première "*awa,*" redoublement de "*wa.*"

A Canala, la pierre s'appelle "*ghe*"; à Houaïlou, "*peïa.*" Il n'y a certainement aucun rapport entre ces deux mots; mais si vous prenez les autres termes qui, dans ces mêmes dialectes, renferment le sens de "pierre," vous trouvez à Canala "*pen-wen,*" (dent), littéralement "pierre-bouche." "*Pen,*" de Canala, est l'équivalent de "*peïa,*" Houaïlou. De même à Houaïlou, vous trouvez "*ghi,*" (hache), c'est-à-dire "pierre," répondant à "*ghe,*" de Canala.

A Canala, les cheveux s'appellent "*poum boua,*" (poil-tête); à Houaïlou, "*proro-gwen,*" même signification. Maintenant, cherchez dans le dialecte de Canala, les mots qui ont le sens de "feuille" ou de "fleur," toutes choses que les indigènes confondent avec les cheveux. Vous trouverez "*poura*" (fleur), équivalent de "*poro*" (poil), Houaïlou.

A Canala, l'oeil s'appelle "*kara mê,*" (peau-lumière); à Houaïlou "*pie mê,*" même signification. "*Kara*" et "*pie*" ne se ressem-

Digitized by Google

blent guère; mais on retrouve à Houaïlou la "langue," "*koro-mé*" (peau-bouche); "*koro*," de Houaïlou, répondant à "*kara*," de Canala.

Il y a, entre le premier et le deuxième groupe, de nombreuses ressemblances de mots, comme on peut en juger par le tableau suivant:

	Groupe Sud.	Groupe central.
Terre	*nda, ta*	*ndo, to*
Sagaïe	*ndji*	*ndie*
Roussette	*bu*	*bu*
Nez	*koun*	*kou*
Yeux	*e mê*	*pie mê*
Langue	*kourou-me*	*koulou-me*
Main	*me*	*me*
Ventre	*ou-he*	*pou-he*
Vent	*kouie*	*kwende*
Arbre	*ngoue, ngwe*	*kwen*
Je, moi	*ngo*	*ngou*
Lune	*m boë*	*boue*
Feu	*ni*	*ne*

Il existe encore, entre ces deux groupes, d'autres points de rapprochement: ils ne font pas usage de l'article; ils n'ont aucune forme particulière de conjugaison. Enfin, sauf de très rares exceptions, tous les mots se terminent par des voyelles. Les désinences consonnales sont à peu près inconnues. Outre les mots cités plus haut, on peut prendre comme exemples les noms de lieux: "*Houaïlou*," "*Kwa-wa*," "*Nakety*," "*Tio*," "*Cio*," "*Bourendi*," "*Ounia*," "*Kunié*," "*Goro*," "*Touaourou*," "*Ma*," "*Mara*," "*Mato*," "*Ngo*," "*Boulari*," "*Wameni*," etc., etc.

Ces particularités suffisent, à mon avis, pour séparer ces deux premiers groupes du troisième, qui comprend tout le Nord de l'Ile, et qui présente plusieurs caractères intéressants.

Troisiéme Groupe ou Groupe Nord.

Ce troisème groupe est d'abord d'une détermination très difficile. On sent qu'il y a eu là un mélange provenant peut-être de plusieurs

Digitized by Google

migrations différentes, qui ont détruit l'harmonie de la langue primitive, en y introduisant des éléments nouveaux.

Les racines sont identiques à celles des deux premiers groupes, et la ressemblance entre les mots subsiste quelquefois entièrement. Ainsi, dans beaucoup de dialectes du Centre, l'eau s'appelle "*wa*"; à Pouebo, qui appartient au groupe Nord, elle s'appelle "*waï*," forme qu'on retrouve en Nouvelle Guinée et chez les Polynésiens.

A Hienghen, groupe Nord, le bois s'appelle "*tiê*"; à Canala, groupe central, le casse-tête, qui est bois, s'appelle "*diâ.*"

A Balade, boire: "*oundou*"; à Canala, "*wendió.*"

A Hienghen, pierre: "*paë*"; à Houaïlou, pierre, "*peïâ.*"

Mais ce qui sépare surtout ce groupe des deux autres, c'est d'abord, comme je l'ai dit plus haut, la prononciation. Les désinences consonnales sont nombreuses et se remarquent jusque dans les noms de lieux: "*Hienghen,*" "*Wagap,*" "*Oubatch,*" "*Pam,*" "*Belep,*" "*Balad,*" "*Koumac,*" "*Gatop,*" "*Gomen.*"

A Wagap, le bois s'appelle: "*tiout*"; à Pouebo, "*tietz*"; à Balade, "*yek*"; chez les Wébiás, "*tiêk*"; la canne à sucre—"*kouss,*" "*kounz*"; l'arc—"*djingheh,*" "*tingheh,*" "*digher*"; le filet—"*pou ess,*" "*poui hat*"; le feu—"*yep,*" "*yak*"; la terre—"*dilis,*" "*gan gouss*"; etc., etc.

Ces dénominations semblent n'avoir plus rien de commun avec celles dont se servent les indigènes du Centre et du Sud.

Les dialectes du Nord possèdent l'article, qui manque dans les autres. A Wagap, "*a*" pour le singulier, "*ni*" pour le pluriel: "*a tiout*"—le bois; "*a bouam*"—la bouche; "*a him*"—le bras; "*ni pe tchouam*"—les dents; "*ni meni*"—les oiseaux; "*ni wen*"—le sable.

Je crois devoir également signaler, dans ces dialectes, une forme particulière de conjugaison qui n'existe pas dans les deux premiers groupes. Cette conjugaison s'applique à tous les mots, aussi bien aux adjectifs et aux substantifs qu'aux verbes. Mais c'est un

Digitized by Google

point sur lequel je m'étendrai davantage quand je parlerai des dialectes des îles Loyalty.

Groupe des îles Loyalty.

On peut, en effet, considérer comme formant un quatrième groupe, les dialectes de ces îles, qui offrent de nombreux rapprochements avec ceux du Nord de la Nouvelle-Calédonie. Je ne parle ici que de Maré, Lifou, et de la partie d'Ouveá comprenant les tribus de *Fayawé* et *Oniott*. L'autre partie, qui doit porter le nom d'Ouveá proprement dit, est occupee par des émigrants polynésiens qui sont venus à la fin du siècle dernier ou au commencemsnt de celui-ci, de l'île d'Ouveá, du groupe des Wallis. Ces émigrants ont conservé leur langue maternelle, qui se rattache au polynésien de Samoa.

Dans ce nouveau groupe, les désinences consonnales sont fréquentes, comme dans les dialectes du Nord de la Nouvelle-Calédonie. A Lifou,—barbe, "*pene naz*"; main, "*im*"; nager, "*haz*"; sang, "*khel*"; taros, "*inangat*"; voir, "*wang*"; yeux, "*ala mek.*"

Les indigènes de ces îles se servent aussi de l'article. A Lifou, "*la*" pour le singulier; "*la ite*" ou simplement "*ite*" pour le pluriel. "*La ouma,*" la maison; "*la ite ouma,*" ou "*ite ouma,*" les maisons.

Enfin ces dialectes possèdent une forme conjugative d'un caractère particulier, que j'ai signalée plus haut dans les dialectes du Nord de la Nouvelle-Calédonie, et qui mérite d'attirer particulièrement notre attention.

Cette conjugaison se compose d'un radical, qui est le mot à conjuguer, et d'une terminaison qui est un véritable pronom personnel. La terminaison fait corps avec le radical, comme dans les conjugaisons grecque et latine.

Cette conjugaison ne s'applique pas seulement aux verbes. Elle peut s'employer, d'une façon générale, pour toutes les parties du discours, même pour les adverbes et les prépositions, ce qui revient à dire que, dans les dialectes de cette catégorie, le discours ne se divise pas, comme dans les langues plus avancées, en différentes

Digitized by Google

parties. Il n'y a, à proprement parler, que deux sortes de mots: ceux qui se conjuguent, et ceux qui ne se conjuguent pas.

Dans les dialectes du Centre, où cette forme n'existe pas, le pronom personnel, qui sert en même temps d'adjectif possessif, se placera à côté du mot auquel il se rapporte, mais sans perdre son individualité. A Canala, par exemple: "*boua-nen*" veut dire: ma tête, ou plutôt:—tête-moi; "*boua-ro*," tête toi; "boua-re," tête-lui. Les mots "*nen*," "*ro*," "*re*," sont des pronoms personnels qui font office de pronoms possessifs, sans faire corps avec le substantif "*boua*." Il y a bien conjugaison, mais sans agglutination du pronom et du mot conjugué.

Il n'en est pas de même aux Loyalty et dans les dialectes du Nord. Là, le pronom s'agglutine quelquefois, sous forme de terminaison, au mot auquel il se rapporte, et fait entièrement corps avec lui.

Le mot "*bo*," tête, se conjugue de la manière suivants:—

Singulier
- 1ère personne *Bo k*, tête-moi;
- 2ème „ *Bo m*, tête-toi;
- 3ème „ *Bo n*, tête-lui;

Duel
- 1ère personne: *Botou*, têtes nous deux, à toi et à moi;
- 1e „ *Bohmou*, têtes nous deux, à lui et à moi;
- 2e „ *Bohbou*, têtes vous deux;
- 3e „ *Borou*, têtes eux deux.

Pluriel
- 1ère personne: *Bota* ou *boutin*, têtes nous—(y compris celui à qui l'on parle).
- 1ère „ *Bohmoun*, têtes nous—(non compris celui à qui l'on parle).
- 2e „ *Bohboun*, têtes vous;
- 3e „ *Bo rin* ou *bora*, têtes eux.

J'ai dit que cette conjugaison s'appliquait à différentes sortes de mots. Ainsi, dans le même dialecte d'Ouveà, district de Fayawé, le verbe "*ebewe*," ou plus simplement "*ewe*"—aimer—se conjugue de la manière suivante:—

Digitized by Google

Singulier
- *Ebewek*—Moi aimer
- *Ebewem*—Toi aimer
- *Ewan*—Lui aimer.

Duel
- *Ewetou*—Nous deux, (toi et moi) aimer
- *Ewehmou*—Nous deux, (lui et moi) aimer
- *Ewehbou*—Vous deux aimer
- *Ewerou*—Eux deux aimer.

Pluriel
- *Ewetin*—Nous aimer, (y compris celui à qui l'on parle)
- *Ewehmoun*—Nous aimer (non compris celui à qui l'on parle)
- *Ewehboun*—Vous aimer
- *Ewerin*, ou *ewera*—Eux aimer.

Voici maintenant un exemple de préposition conjuguée d' après le même système :—

Ben—avant (Ouvéa).

Singulier
- *Beuk*—Moi avant
- *Beum*—Toi avant
- *Beun*—Lui avant

Duel
- *Beu tou*—Nous deux (toi et moi) avant
- *Beuhmou*—Nous deux (lui et moi) avant
- *Beuhbou*—Vous deux avant
- *Beurou*—Eux deux avant

Pluriel
- *Beutin*—Nous avant (y compris celui à qui l'on parle)
- *Beuhmoun*—Nous avant (non compris celui à qui l'on parle)
- *Beuhboun*—Vous avant
- *Beurin*—Eux avant

Bien que cette forme de conjugaison soit d'un emploi fréquent dans les dialectes des Loyalty et du Nord de la Nouvelle-Calédonie, je ne crois pas qu'elle leur appartienne en propre, car elle me paraît exister également dans plusieurs dialectes des Nouvelles Hébrides, des îles Salomon, des Santa-Cruz, etc., etc.

A Paama, (Nouvelles Hébrides), on dit : "*batouk*," tête-moi ; "*batoum*." tête-toi ; "*batoun*," tête-lui ; aux îles Torrès, "*koutouk*," tête-moi ; "*koutoum*," tête-toi ; "*koutoun*," tête-lui, etc., etc.

Digitized by Google

Les terminaisons sont toujours les mêmes : *k* ou *g* pour la première personne du singulier, *m* pour la deuxième, *n* pour la troisième.

Autant que j'ai pu en juger, cette conjugaison n'existerait pas dans les dialectes polynésiens. Je ne l'ai rencontrée dans aucune de leurs grammaires. Elle serait donc propre aux dialectes papous dont elle constituerait un des caractères les plus saillants. Elle convient d'ailleurs si bien à la manière de penser des indigènes, qu'il leur est difficile de concevoir un objet sans l'attribuer immédiatement à une personne quelconque. Demandez leur, par exemple, comment ils appellent la tête, prise dans un sens abstrait: ils ne vous comprendront pas, et vous demanderont : "De quelle tête veux-tu parler ? de la tienne, de la mienne, ou de celle d'une autre personne ?"

Ils sont absolument dépourvus du sens de l'abstraction.

Grammaire.

Malgré les particularités que je viens de signaler, les dialectes de la Nouvelle-Calédonie et ceux des Loyalty, ont entre eux un caractère incontestable de parenté, non seulement pour les racines et pour les mots, mais pour l'organisme rudimentaire de leur grammaire.

Genres.

Les genres n'existent pas. La distinction entre le masculin et le féminin, se fait au moyen de mots qui ont le sens de mâle ou de femelle. A Canala, on se sert des mots : "*oto*,"—homme—et "*sien*,"—femme. A Lifou, on emploie les mots : "*taman*" et "*feu*," qui ont la même signification : "*goutou taman*"—coq ; "*goutou feu*," poule.

Nombres.

Il y a trois nombres : le singulier, le duel et le pluriel. Ces nombres sont généralement déterminés par des pronoms personnels; les autres mots sont invariables, à l'exception de l'article, qui, comme on l'a vu plus haut, comprend quelquefois deux formes : une pour le singulier et une autre pour le pluriel.

Digitized by Google

A Canala, "*non*" désigne indistinctement le poisson ou les poissons. Pour exprimer la pluralité, on se sert des mots "*bicho*" ou "*chamouen non*,"—beaucoup-poissons. La rivière, "*wen re*"; —les rivières, "*wen re*";—beaucoup rivières, "*bicho wen re*."

A Ouvéa, on dira :—la maison, "*ouma*";—les maisons, "*ouma*"; —beaucoup maisons, "*taïe ouma*."

Adjectifs, substantifs et verbes.

Les adjectifs et les verbes se ramènent tous à des substantifs.

Les adjectifs : chaud, clair, blanc, rouge, etc.; sont exprimés par des mots qui ont le sens de feu.

Au grand Moindou :—blanc, "*we*"; à Houaïlou, le jour, "*wa*"; à l'île des Pins, blanc, "*baa*"; aux Loyalty, le jour, "*laa*" "*la*."

Toutes ces formes : "*we*," "*wa*," "*baa*," "*laa*," sont identiques, par suite du changement constant, que j'ai déjà signalé, de "*w*" en "*m*," "*b*," "*p*," "*f*," "*l*," "*r*."

A la Wameni : "*me*" blanc ; "*ma*," rouge ; à Canala : "*men*" chaud ; "*mien*," soleil, dans "*ka mien*," chose-feu. Dans les mêmes dialectes, l'oeil s'appelle : "*me*," "*meï*," c'est à dire-lumière.

Dans les dialectes du Nord, "*wa*," devient "*ya*," feu ; à Gomen, "*a*," soleil. Dans le groupe central, à Canala, la Foa, Moindou, Bourail, "*a*" prend le sens de jour dans "*a chi*," "*a chou*," "*a cheu*," "*a jé*," soleil, littéralement : jour-feu. Le soleil est le feu du jour, comme la lune : "*bo-je*," est le feu de la nuit.

Le vert et le bleu se désignent par des mots qui ont le sens de feuille : "*poun*."

Ce qui est chaud étant "feu," ce qui est froid, par opposition, est "eau." A Houaïlou : "*ja*," "*cha*," eau ; "*jaon*," "*chaon*," froid.

D'autre part, "feu" étant l'équivalent de "blanc," "eau" devient l'équivalent de "noir," et je trouve un exemple frappant de cette manière de parler dans les dialectes australiens :

A l'île Moreton : "*kuppee*,"[1] nuit ; "*kuppee*," sombre, noir— "*kuppeng*," eau.

[1] Tous les mots australiens sont extraits de l'ouvrage de M. Edward Curr, *The Australian Race*, Melbourne 1886.

Digitized by Google

En Nouvelle-Caledonie, l'eau s'appelle : "*po*," "*fo*," "*foa*"; la nuit, c'est à dire ce qui est noir, s'appelle "*bo*," "*poua*," "*poë*," etc., etc.

Voir, c'est œil, c'est à dire feu ; dormir, c'est nuit, c'est à dire eau. "*Wa*," "*ya*," feu—devient à Lifou, "*waang*," voir. "*Ne*," feu—devient à Hienghene "*We ne*," voir—littéralement faire lumière, faire feu.

A Ouvéa : voir, "*maha wa*," "*meu wa*," faire feu.

A Aoba, (Nouvelles-Hébrides) "*tourou*"—nuit et noir—"*ma tourou*," dormir, faire nuit. La même racine : "*tor*," "*tour*," désigne l'eau dans un grand nombre de dialectes.

A Houaïlou : "*koulou*," dormir, racine "*kol*," "*koul*," désignant —l'eau, la pluie, la nuit—tout ce qui est froid, humide et sombre.

Boire, c'est encore "eau." A Canala, eau, "*kwe*"; boire, "*kwen*"; Lifou, boire, "*kwa*," semi-durcissement de "*wa*" eau. Marcher, c'est terre—"*Ware*," terre; devient "*vara*" et "*fara*," marcher.

Parler, c'est bouche. "*Wa*," bouche, devient "*me*," "*mea*," parler.

"Faire" et "travailler" sont des idées équivalentes qui s'expriment par des mots ayant le sens de "main." C'est la main qui fait, qui travaille. "Faire," dans un grand nombre de dialectes, se dit : "*ma*," "*me*," "*meu*," "*maha*," pour "*maka*." A Canala, et dans tous les dialectes du Sud, la main, "*me*." Canala : travailler, "*wake*," équivalant à "*maka*," faire. Les Polynésiens disent : "*waka*," "*faka*" et "*maka*," faire.

Maré : faire, "*roue*"; travailler, "*rouat*."

Par suite de cet organisme, les racines verbales, que l'on signale en si grand nombre, à tort ou à raison, dans les langues Indo-européennes, n'existent pas dans les dialectes Neó-calédoniens. Dans ces dialectes, ce sont les substantifs qui forment les verbes, et il doit en être de même pour les dialectes australiens et polynésiens.

Les adjectifs sont invariables, comme les noms.

Digitized by Google

Les verbes n'ont qu'un mode : l'infinitif, et qu'un temps : le présent. Le passé et le futur s'expriment par des mots qui signifient : finir, ou—" tout-à-l'heure."

A Ouvéa : "*oubden*," pour le passé, et "*dioao*" pour le futur : j'ai mangé—"*o ghe oubden hann*," moi finir manger. Je mangerai, "*inie hann dioao*"—moi manger tout à l'heure.

A Canala : j'ai mangé, "*nen da monron*"—moi manger finir ; je mangerai, "*me nane da re*,"—tout à l'heure, moi manger tout à l'heure.

Le verbe avoir existe, mais non comme auxiliaire ; Tobi a une canne à sucre—(Ouvéa): "*chou Tobi aaku*,"—avoir Tobi canne à sucre.

Le verbe être n'existe nulle part. Je suis bon (Canala). "*nen ourou*"—moi bon. Je suis malade (Ouvéa), "*ya mmok*,"—moi malade.

Pronoms.

Les pronoms et adjectifs possessifs sont, comme on l' a vu plus haut, remplacés par des pronoms personnels. A Canala : "*boua nen*"—tête-moi, pour : ma tête, etc., etc.

Je ne serais pas éloigné de croire qu'il en est de même pour les pronoms et adjectifs démonstratifs. mais c'est une question que je n'ai pas suffisamment élucidée.

A Canala : celui-ci, ceux-ci, celle-ci—"*we-ya*," "*wen-ya*."

Dans le même dialecte, "*we*" devient "*a*," et se place avant et après le mot auquel il se rapporte. Dans ce cas, il prend plus particulièrement le sens de l'adverbe "là": Ce coco—"*a nou a*"—là coco là ; ce coq, "*a do a*,"—là coq là.

A Ouvéa, celui-ci, celle-ci : "*ang*," qui est l'équivalent de "*a*" (Canala): Cet oiseau—"*meno ang*"—oiseau là ; ce caillou, "*ueto ang*," caillou là.

Numération.

La numération, dans tous ces dialectes, est à base de cinq, et, malgré les altérations profondes qu'ont subies les noms de nombres, on peut encore reconnaître de quelle manière elle s'est formée.

Digitized by Google

Elle a pour point de départ le nombre "un," qui s'ajoute successivement à lui—même :—"deux," c'est "un-un"; trois, c'est "un-deux"; quatre, c'est "un-trois.

Canala : "*cha*"-un ; Bourail, "*cha ken*,"-un, par redoublement, "*cha*" n'étant que la forme aspirée de "*ka*," qui équivaut à "*ken*."

Puis la série continue régulièrement : "*ken ourou*," ou "*ken rou*" "un-un," c'est à dire "deux."

"*Ken rli*"—un-deux, c'est à dire trois.

"*Ken re*"—un-trois, c'est à dire quatre.

Le nombre cinq s'exprime par des mots qui ont le sens de main. Dans les dialectes du Nord, "*nem*," "*nim*," cinq, à rapprocher du polynésien "*nima*," main, et cinq.

A Saint-Vincent, groupe Sud : "*tanganga*," cinq—à rapprocher du Malais "*tangang*," main.

A partir du nombre de cinq, on dit : "main-un" six; "main-deux," sept ; "main-trois," huit ; "main-quatre," neuf.

A Bourail : "*kenni*," cinq, c'est à dire une main ; "*kenni daken*," six; "*kenni ken ourou*," sept ; "*kenni kenrli*," huit ; "*kenni kenre*," neuf.

Le nombre dix s'exprime par des mots qui veulent dire : deux mains.

Dans le groupe Sud, par exemple : "*ta*,"-un, et "*boou*,"-deux ; "*ta kuen*," cinq, c'est-à-dire une main ; et "*bo kuen*," dix. c'est-à-dire deux mains.

Les dialectes néo-Calédoniens diffèrent sur ce point des dialectes polynésiens, où les mots qui désignent le nombre "dix," ont le sens de "tête." Tonga : "*ongo oulou*," une tête—c'est-à-dire "dix."

Mais il y a lieu de remarquer, d'autre part, que cette manière de compter des néo-calédoniens, est absolument semblable à celle des Aryens. Le latin "*quater*" veut dire: un-trois. Le sanscrit dit : "*pan kan*," cinq, c'est-à-dire une main, et "*da kan*," dix, c'est-à-dire deux mains.

Digitized by Google

Monosyllabisme.

La plupart des mots dont se servent les néo-calédoniens sont des monosyllabes.

Ce sont des dialectes qui sortent à peine du monosyllabisme, et, à cet égard, ils diffèrent sensiblement des autres dialectes papous, ainsi que du polynésien.

La main, "*him*"; le pied "*pa*"; la bouche "*wa*," "*po*," "*fo*"; la tête, "*boua*"; la terre, "*ta*"; le feu, "*ni*"; etc., etc.

Pour les mots qui paraissent formés de deux ou plusieurs syllabes le plus souvent l'agglutination n'existe pas. Le monosyllabisme est persistant :—"*a-jé*"—soleil, jour-feu ; "*bo jé*" lune, nuit-feu; "*pe-wen*"—dent, pierre-bouche; "*poum-boua*"—cheveux, poils-tête; "*woen re*"—rivière, eau couler; "*pie mé*"—œil, peau-lumière; "*tio kan*"—la mer, eau grande; "*wa tin*"—lait, eau-seins ; "*po ne-ri-wen*"—bouche-rivière-couler-eau ; l'embouchure de la rivière.

Cependant, à coté de ces formes qui sont les plus primitives et les plus nombreuses, il en existe d'autres qui proviennent, sans aucun doute, du redoublement de la racine monosyllabique. "*Wa*" -terre—devient "*ma*," et par redoublement : "*mara*," "*mere*," "*mare*"; même signification (changement du "*w*" en "*m*" et en "*r*.") "*Ware*," "*waraï*," "*bouraï*," sont également des formes redoublées de la racine "*wa*"-terre.

"*Wa*" devient encore "*papa*," le sol, le sec, le dur ; "*ba, pa*," montagne (*ba kwindé*, kwindé-la-montagne); "*pa*"-pied ; "*vara*," "*fara*," marcher.

D'autre part, "*W*" se durcit en "*K*," et fournit une nouvelle série de formes redoublées: "*wa-wa*," devient "*wa-ka*," "*wa-ko*," "*ma to*," "*ue to*," "*ui toë*," "*vata*"; etc., etc.

Il est nécessaire de se rappeler ici ce qui a été dit plus haut de l'extrême mobilité des racines, et de la nécessité de les suivre très attentivement sous leurs diverses formes, pour saisir leur évolution.

Manière de parler des Néo-Calédoniens.

On peut maintenant se rendre compte, par les exemples cités plus haut, de la manière de parler des Néo-Calédoniens et du

Digitized by Google

fonctionnement de la pensée chez ces peuplades. Il leur suffit de quelques mots, exprimant des idées éminemment concrètes, pour désigner un grand nombre de choses.

Tont ce qui brille, tout ce qui brûle, tout ce qui est blanc, rouge, clair :—les yeux, le soleil, le jour, la lumière ; tout cela s'exprime par des mots qui ont le sens de "feu."

Tout ce qui est mou, froid, humide :—le nuage, la nuit, la brume, la fumée, les parties molles du corps, tout cela s'exprime par des mots qui servent à désigner l'eau. Il y a, dans les dialectes néo-calédoniens, une confusion de mots qui paraît très embarrassante au premier abord : ce sont les mêmes expressions—"*wa*," "*boua*," "*poua*," "*moua*," "*bo*," "*po*," "*fo*"; etc., etc., qui désignent : l'eau, le nuage, la nuit, la fumée, et la bouche. Mais dès qu'on pénètre le véritable sens de ces mots, on s'aperçoit que cette assimilation n'est pas due au hasard, et qu'elle est au contraire, basée sur la nature même des choses. La nuit, qui est froide et humide, qui produit la rosée, a dû être, dans les premiers âges de l'humanité, identifiée à l'eau, de même que le nuage, qui est également froid, humide et qui produit la pluie, de même que la bouche, qui est toujours humide.

Tous les objets en bois sont désignés par des mots qui ont le sens de bois. C'est à peine si, de temps à autre, on y ajoute un autre mot, toujours monosyllabique, indiquant la destination de ce bois.

Dans les dialectes du Nord, le bois s'appelle: "*ke*," "*kie*," "*tie*"; le panier : "*ket*," "*ke*"; l'aviron : "*kat*"; la navette : "*di*"; le bâton: "*die*." A Pouebo, "*die-gan*,"—bâton, littéralement : bois-marcher.

Dans les dialectes du Centre, le bois : "*ken*," "*ke*"; le bâton : "*ke*," ou "*dio*"; le casse-tête : "*dia*"; la canne à sucre : "*de*," "*ti*"; le panier : "*ke*"; la sagaïe : "*n'dio*," "*n'diou*."

Aux Loyalty, le bois: "*gwi*"; la sagaïe: "*zo*"; la pioche : "*ze*"; la flûte: "*zic*"; le casse-tête : "*vzia*"; l'écuelle: "*tie*"; dans "*sine-tie*," eau-bois.

Digitized by Google

L'os s'appelle comme la pierre : "*ghi*"; à Ouvéa, "*dieu*," mot qui, dans d'autres dialectes, a le sens de bois. Je remarque, dans les dialectes australiens, la même identification entre l'os et la bois:

Mount Gambier : "*baa*"-os ; "*baa*-bois ;
Hamilton River : "*bunda*-os ; "*bunda*"-bois ;
Western River : "*toola*"-os ; "*toola*"-bois ;
London River : "*kaalk*"-os ; "*kaalk*"-bois ; etc.

J'ai pu m'assurer, par de nombreux exemples, que la même maniére de parler existe dans tous le dialectes mélanésiens et polynésiens. Nous sommes ici en présence d'une loi générale d'après laquelle l'homme, dans le principe, a confondu l'os avec la pierre ou le bois.

La terre, c'est ce qui est solide, dur, sec, (ces trois adjectifs sont équivalents) par opposition à l'eau, qui est molle et liquide. Nous connaissons déjà la racine "*wa*"—terre—qui devient: "*ma*," "*ba*," "*pa*"; pour désigner les caps, les montagnes, les lieux élevés. A Maré, "*papa*,"—sec, solide, dur—et terre. Dans l'intérieur de cette île, qui est de formation madréporique, il existe un endroit où le sol primitif a fait éruption au dessus du corail. Cet endroit s'appelle "*rawa*" terre, forme redoublée de "*wa*."

On m'objectera que la qualification de "dur" peut s'appliquer aussi bien au bois et à la pierre, qu'à la terre. Mais c'est précisément ce qui a lieu. Les dialectes néo-calédoniens, comme d'ailleurs ceux des groupes australien et polynésien, conservent les traces d'un état primitif, dans lequel l'homme n'avait pas encore la conception exacte des objets qui l'entouraient, et confondait entre elles toutes les choses dures.

A Canala : "*kwen*" bois ; dans d'autres dialectes du même groupe : "*kwe*"—l'intérieur du pays, la terre.

A l'Ile des Pins : "*poue*," bois ; "*boue*,"—place, endroit—c'est-à-dire "terre"; et "*poue*"—hameçon, c'est-à-dire bois ou pierre ; dans les dialectes du Nord, "*boua*," "*poua*"—bâton, casse-tête-c'est-à-dire "bois."

A Poya, la terre : "*ndo*"; à Balade, l'os : "*dou*."

Digitized by Google

Dans plusieurs dialectes, "*a wi*," forêt—littéralement :—chose bois; racine "*wi*," qu'on retrouve à Canala, avec le sens de "pierre," dans "*me wi*,"—pierre de fronde—littéralement : faire-pierre ; à Houaïlou, avec le sens de "bois," dans, "*den wi*," feuille: cheveu bois ; à Maré : "*gwi*"—bois, et dans presque tous les autres dialectes, "*ghi*"—pierre.

Les dialectes australiens offrent de nombreux exemples de la même confusion entre le bois, la terre et la pierre : Roxburgh Downs, bois, "*mukka*"; pierre, "*mukka*"; de Port-Denison au Cap Gloucester : bois, "*baree*"; pierre, "*paree*"; Beylando : bois, "*baïi*"; pierre, "*paë*"; (la même forme que dans les dialectes néo-calédoniens). Tenterfield (New England): terre, "*tarri*"; pierre, "*tarro*."

Il est à remarquer qu'une confusion exactement semblable a dû exister chez les races aryennes, car le sanscrit nous offre les rapprochements suivants : "*Dara*," dur ; "*dhara*," terre ; "*daru*," bois ; "*dardara*," montagne, c'est-à-dire "terre" ou "pierre"; "*danta*," dent, c'est-à-dire "pierre" ou "os"; et "*danda*," bâton, c'est-à-dire "bois."

Le Breton dit : "*kaled*," dur ; le latin : "*calus*," durillon ; "*calculus*," caillou ; et "*cala*," bûche.

On est en droit de se demander, en présence de ces exemples, si les Aryens, nos pères, n'ont pas passé par les mêmes étapes que les Papous et les Australiens, et s'ils n'ont pas commencé par embrasser d'abord, dans une synthèse générale, tout ce qui est dur, pour arriver ensuite graduellement, d'analyse en analyse, à distinguer, par des formes spéciales, des substances qui diffèrent essentiellement les unes des autres, et qui n'ont entre elles qu'un rapport commun : la dureté.

L'air s'appelle comme l'eau. A Maré, air, "*nono*," forme qui dans un grand nombre de dialectes, désigne l'eau.

Les animaux sont désignés d'après le milieu dans lequel ils vivent : le poisson, "*no*," eau ; le moustique, "*no*," "*non*," air. L'oiseau, "*me-no*"—"*me-nou*"—"*ma-nou*," animal—air ; ou bien "*me-we*," racine "*we*," désignant l'eau, et par suite, l'air.

Digitized by Google

La "roussette" (flying-fox) s'appelle : "*bu*," "*peu*," formes désignant également l'eau et l'air, et se retrouvant dans le polynésien "*pe ka*," roussette—littéralement : air-animal.

L'homme s'appelle : *ka mourou*," "*a mboro*," "*ourou*," "*ore*"; "*ka*," animal ; "*mourou*," "*ourou*," courir—ou plus exactement : animal-terre. "*Ourou*" est à rapprocher du malais "*orang*," homme—et cette forme n'est elle-même qu'une mutilation de la racine "*gour*," "*kour*," qui, dans tous les dialectes malayo-polynésiens, désigne les animaux terrestres.

Les Australiens appellent l'opossum, "*tu ngor*," "*tha ngaroo*" le kangurou : "*ko ngoora*"—"*yungar*." L'homme lui-même, dans certains dialectes, s'appelle "*yungar*," comme le kangurou. Toutes ces formes ont le sens de : terre-animal, et les racines "*gar*," "*goor*," sont équivalentes du Malayo-polynésien "*gour*," "*kour*," "*or*," ainsi que du néo-caledonien "*our*."

La femme est au contraire "animal-eau," ou "animal-lait," le lait étant identifié avec l'eau. A Hienghen, la femme, "*nok*" ou "*no*," comme le poisson. A Pouébo : "*tea-bo*," "*te-bo*"—littéralement : "homme-lait," l' homme qui a du lait.

A Canala : "*sien*," racine "*si*," "*ti*," qui désigne l'eau, le lait et les seins.

En Nouvelle-Zélande, "femme," "*o wa*," racine "*wa*," eau ; à Madagascar, "*vave*," femme ; à Tahïti : "*vaï*," eau.

Tahïti : mère, "*taï*"; Tonga et Nouvelle-Zélande : mer, "*taï*."[1]

En Australie, l'assimilation est encore plus complète. La femme s'appelle comme le sein ; le sein, comme le lait ; et le lait, c'est "eau."

Shark's Bay : eau, "*baba*"; seins, "*baba*"; Nichol Bay : lait, "*bibi*," seins, "*bibi*"; femme, "*bibi*"; etc., etc.

Ailleurs, l'eau s'appelle "*ngammoo*"; le lait, "*ngammon*"; la femme, "*ngammia*."

Ici encore les Aryens paraissent avoir parlé comme les Australiens et les Mélanésiens. Le Latin dit : "*Ju piter*"—Dieu-père ;

[1] Tous les mots polynésiens tout extraits du *Voyage de l'Astrolabe*, par Dumont d'Urville, Paris 1832.

Digitized by Google

et "*Ju no.*" Dieu-mère : racine "*no,*" qui désigne l'eau, et qui se retrouve dans "*nuit,*" "*nue,*" "*nuage,*" c'est-à-dire ce qui est froid, ce qui est humide, ce qui est "eau."

Noms de lieux.

Les noms de lieux ont généralement le sens de terre ou de rivière. Quelquefois ils désignent une particularité physique ou géographique : "*Ma,*" "*mara,*" "*mere,*" "*mare,*" "*ware,*" "*waraï,*" "*bouaraï,*" terre; "*mato,*" "*vata,*" "*uitö,*" rocher; "*kone,*" "*kunie,*" "*Ounia,*" terre ; "*A we,*" "*ewe,*" "*diawe,*" "*yawe,*" rivière; "*Foa,*" "*ti,*" "*tio,*" "*cio,*" rivière ; "*Bo ghen,*" "*boua ken,*" "*yenghen,*" eau-grande. "*Dia hot,*" nom de fleuve, eau-grande ; "*Ti kan,*" la mer, eau-grande ; "*Ti waka,*" rivière-pirogues ; "*Wa-meni,*" rivière-oiseaux ; "*Witch-ambe,*" montagne haute ; "*Boul ari,*" "*Bouloup ari,*" terre rouge ; "*Bélep,*" terre ; "*Wen,*" terre ; île ; "*Nou,*" "*nani,*" île ; etc., etc.

Certains noms de lieux semblent rappeler des souvenirs étrangers "*Go meni,*" et "*Kou maki,*" (Gomen et Koumac) se retrouvent en Nouvelle-Guinée "*Yaté*" se retrouve à Torrès ; "*Ouvéa*" vient des îles Wallis.

Conclusion.

En résumé, les dialectes néo-calédoniens ont une physionomie particulière, qui se fait surtout remarquer par son extrême simplicité. La langue n'a aucune précision ; les racines sont dans un état perpétuel de fluctuation, et affectent les formes les plus variées. Les différentes parties du discours n'existent pas. Le même mot peut être pris successivement comme substantif, comme adjectif ou comme verbe. Le monosyllabisme est dominant, et les racines ont conservé une signification synthétique qui ne se rencontre peut-être au même degré dans aucune autre langue. Ce sont les plus primitifs des dialectes "papous."

Maintenant, qu'il me soit permis de poser une question : Où commence le "papou"? où finissent l'australien et le polynésien? Un examen approfondi de cette question nous entraînerait trop loin. Cependant, voici ce que je crois être la vérité.

Digitized by Google

D'abord, pour ce qui concerne le groupe "papou," il n' y a pas de langue proprement dite. Non seulement ces dialectes présentent la même confusion que ceux de la Nouvelle Calédonie, mais ils ont subi, en outre, l'influence du Malais à une si forte dose, qu'ils ont perdu toute leur originalité première. Ils sont bien inférieurs, sous ce rapport, aux dialectes néo-calédoniens. Si, d'autre part, je compare les dialectes "papous" à ceux de l'Australie ou au polynésien, je remarque entre eux, il est vrai, de grandes différences de prononciation provenant, comme je l'ai dit plus haut, de la grande mobilité du langage, qui n'est pas encore fixé. Je vois aussi des formes locales, des différences grammaticales qui, au premier abord, semblent devoir écarter toute idée de rapprochement; mais au fond les racines sont les mêmes. C'est ce qu'un exemple fera encore mieux ressortir.

Les Néo-Calédoniens, les Papous en général et les Polynésiens, se servent, pour désigner l'eau, de la racine "*wa*," "*ba*," "*pa*," "*va*," etc.; qui prend encore les formes les plus variées.

Dans les dialectes australiens, cette racine n'apparaît qu'accidentellement, comme dans les dialectes de "Nickol Bay" et "Shaw River," où l'eau s'appelle—"*babba*," "*babba*,"—tandis que dans la plupart des autres dialectes, elle s'appelle "*kauwee*," "*kaba*," "*kamoo*," "*a moo*," etc., etc.; Mais si l'on examine ces formes avec attention, on ne tarde pas à reconnaître que la véritable racine est "*wee*," "*ba*," "*moo*," tandis que la première syllabe:—"*ka*," "*a*," n'est qu'un préfixe, ayant probablement le sens de chose "*ka ba*," "*ka moo*," "chose-eau." La racine "*wee*" (pour "*wa*"), "*ba*," "*moo*," évolue exactement comme chez les néo-Calédoniens. Les formes sont identiques de part et d'autre.

Les Australiens disent: "*ke ni*," "*ka ri*," "*ko la*," soleil. Les véritables racines sont: "*ni*," "*ri*," "*la*"; qu'on retrouve dans le néo-calédonien: "*ni*," feu; dans le polynésien: "*la*," lumière; et dans "*ari*," forme mutilée de "*ka ri*."

Quant aux ressemblances de mots, elles abondent entre tous ces dialectes. La forme "*mé*," qui sert aux Néo-Calédoniens pour

Digitized by Google

désigner l'œil, se retrouve à chaque instant dans les dialectes australiens, avec le même sens :

Polynésien : " *Wira*," " *Wila*," éclair ;
Australien : " *Wira*," soleil, feu ;
Polynésien : " *Mira*," brillant ; " *miri*," regarder ;
Australien : " *Mir*," œil.
Néo-Calédonien : " *Me*," main ; " *ma*," faire ;
Australien : " *Ma*," main ; etc., etc.

Qu'on prenne tous les dialectes malayo-polynésiens, depuis Madagascar jusqu'à Hawaïi, depuis le malais proprement dit jusqu'au langage si doux de Tahïti ; depuis les Carolines et les Mariannes jusqu'à la Nouvelle-Zélande. Qu'on les compare aux dialectes papous et australiens ; le même phénomène se reproduira toujours. Il y aura des différences locales de prononciation et des formes grammaticales particulières à chaque dialecte ou à chaque groupe ; mais au fond, l'identité des racines est absolue. La dissémination des familles et l'influence des milieux, ont créé des différences de types et de races ; mais le langage, malgré sa grande diversité apparente, est resté immuable, pour attester l'origine commune de toutes ces races.

Digitized by Google

On the PINENES of the OILS of the GENUS EUCALYPTUS.—Part I.

By Henry G. Smith, F.C.S., Technological Museum, Sydney.

[*Read before the Royal Society of N. S. Wales, October 5, 1898.*]

The following paper deals with the investigation of both dextrorotatory and lævorotatory pinenes found existing in the oils of two new species of Eucalyptus growing in New South Wales.[1]

The occurrence of Eucalyptus oils consisting almost entirely of the terpene pinene, is remarkable, and will assist to a very large extent, in enabling us to trace the origin and formation of the several constituents found existing in Eucalyptus oils. That a connection does exist, running through the whole series, seems probable, and it is only by carrying out investigations on oils of undoubted material, that a correct scientific knowledge can be obtained in this direction.

The group of Eucalyptus trees to which these two species belong is known vernacularly as the 'Stringybarks,' and both the species form part of a chemical sub-group of the botanical class of the Eucalypts known as the Renantheræ, or those having kidney-shaped anthers.

We can derive no further help from the investigation of the kinos of this group, because the exudations from all the Eucalypts belonging to the Renantheræ appear to be identical in composition; but the constituents of the oils indicate a sharp distinction. The terpene composing the oils of these two species is principally pinene; not a trace of phellandrene could be detected in them, and so we are enabled to differentiate them from the oils obtained from those trees belonging to the Renantheræ, such as *E. amyg-*

[1] Vide R. T. Baker, F.L.S., on two New Eucalypts—Proc. Linn. Soc., N.S.W., September 1898.

Digitized by Google

dalina, *E. piperita*, *E. coriacea*, etc., the oils of which consist more or less largely of the terpene phellandrene, and those that contain only a small quantity of pinene, or perhaps none at all. Although the two species from which these pinenes were obtained are types, both botanically and chemically, yet it is not to be supposed that oils containing pinene are all devoid of phellandrene, such not being the case. A variety of the Rylstone species (*E. lævopinea*)[1] was obtained from Barber's Creek, the oil of which was found to contain a small quantity of phellandrene, although consisting almost entirely of the lævorotatory pinene identical with the pinene obtained from the type species. It is worth notice that oils containing phellandrene are generally light coloured in their crude state, while those not containing phellandrene are often reddish in colour. This colour is readily removed by agitating with potash, and it is of an acid character. It is not derived from the eucalyptol (?cineol), as about the same minute quantity of eucalyptol was found in the higher boiling portions of the Rylstone oil (a red oil) as was found in that of its variety (oil almost colourless, being light yellowish with a tinge of green). We cannot at present derive much information from the colour of the crude Eucalyptus oils, although it may be found eventually to have some bearing on their constitution.

The almost entire absence of eucalyptol in the oils of certain members of this group, is also very characteristic, and it seems possible that we may eventually be able to decide how this constituent of Eucalyptus oils increases in quantity, as we go up or down the series.

This investigation was carried out on material obtained from Barber's Creek; from Currawang Creek near Braidwood; and from Nullo Mountain near Rylstone, all in this Colony.

The material from Barber's Creek, from which the dextrorotatory pinene was obtained, was botanically identical with that of the species forwarded by the Museum collector from Currawang

[1] Named *E. lævopinea* var. *minor* by Mr. Baker, loc. cit.

Digitized by Google

Creek. This species was described by my colleague Mr. R. T. Baker, *(loc. cit.)* under the name *Eucalyptus dextropinea*, a recognition to the science of chemistry for assistance rendered in the determination of species of this important and difficult genus.

From the results of the determinations of the oils from the leaves of *E. dextropinea*, from both Barber's Creek and Currawang Creek, localities over one hundred miles apart, it might be inferred that the oils were obtained from identical material, and the results again emphasize the fact that the same species of Eucalyptus gives an oil identical in composition, no matter where grown, if collected at the same time of the year. We have other evidence that this is true, and the determination of the oil, together with that of the other chemical constituents of the tree, will be of great assistance in the determination of unknown species. The genus is so prolific in chemical constituents, both crystallised and liquid, that possibly many of the difficulties experienced in the study of the Eucalypts may be effectually removed when the several products of individual trees shall have been systematically investigated by the chemist. The results brought forward in this paper are an instance in point, as the oils of the type species from the three localities possess great similarity; they all consist principally of pinene, and in colour, odour, specific gravity, etc., resemble each other most markedly, yet while the pinene from both the Barber's and Currawang Creeks material rotates the ray of light to the right, the pinene from the Rylstone Eucalypt rotates the ray to the left. The Rylstone material was collected under the personal supervision of Mr. Baker. We cannot admit that a tree giving an oil consisting principally of a dextrorotatory pinene having a specific rotation $= [a]_D + 41{\cdot}2°$ is identical with one giving an oil, also consisting principally of a pinene, that is lævorotatory to even a greater degree, although the differences in some of the botanical material may not be very marked. Mr. Baker, however, informs me that the timber of *E. lævopinea* is excellent, while that of *E. dextropinea* is a comparatively worthless timber.

Digitized by Google

The late Baron von Mueller, whose knowledge of the Eucalypts of Australia was unique, recognised years ago, the possible assistance the botanist might derive in determining differences in species by the results of chemical investigation of their constituents. The reference is so important in connection with the results brought forward in this paper, that I indicate the paragraph, published by the Baron in 1879.[1]

"*E. obliqua* is distinguished from *E. piperita* by . . . and perhaps by anatomic, histologic, *and chemical peculiarieties of the bark and wood which characteristics remain yet more comprehensively to be studied*," The italics are mine.

Since that time much has been done in determining the chemical characteristics of several of the species. The results of the present research not only assisted in finally determining the species, but present possibilities of commercial value in determining the utility or otherwise of the products of the tree by the determination of its chemical constituents. According to Mr. Baker, the Rylstone specimen *(E. lævopinea)* has certain botanical affinities with those of *E. macrorhyncha*, but chemically these two trees are quite distinct, and the importance of this is apparent when it is stated that the leaves of *E. lævopinea* do not contain myrticolorin like those of *E. macrorhyncha*, nor does the oil contain eudesmol and other constituents found in the oil of *E. macrorhyncha*.

The presence of a pinene in the oil from *E. globulus* was detected some time ago. M. Cloez in 1870[2] published the first detailed observations relative to the oil of *E. globulus*. This research is now of historic interest from the fact that he obtained a hydrocarbon $C_{10}H_{16}$ boiling at 165° C., by distilling his so-called eucalyptol with P_2O_5. This terpene he called eucalyptene. Afterwards Faust and Homeyer[3] gave the same name to a terpene from Eucalyptus oil which according to them is a terebenthene, being readily polymerised by sulphuric acid. Later, Wallach and Gildmeister[4]

[1] Eucalyptographia, Decade III., Art. *Eucalyptus piperita*.
[2] Compt. rend. 1870, 687 and Journ. de Pharm. and Chimie 1870, XII. 201.
[3] Ber. 7, 63, 1429. [4] Ann. 246, 265 – 284. Abst. Chem. Soc. 1888, 54, 1205.

Digitized by Google

stated that the hydrocarbon, eucalyptene, from *Eucalyptus globulus*, is identical with dextropinene.

In 1895 Bourchardat and Tardy[1] carried out experiments with the hydrocarbon found occurring in small quantity in the oil of *Eucalyptus globulus*, and arrived at the conclusion that it has the properties of lævorotatory terebinthene found in French oil of turpentine, but with an almost equal opposite rotation. They give its boiling point as 156 – 157° C.; its density as 0·870 at 0° C. and 0·865 at 18° C.; and its specific rotation at 15° C. as $[\alpha]_D + 39°$. They give Riban's determination[2] for the specific rotation of lævorotatory terebenthene as – 40·3°. It appears, therefore, from the results obtained by these authors on this hydrocarbon from the oil of *E. globulus*, and those obtained in this research on the same hydrocarbon from the oil from *E. dextropinea*, that these dextrorotatory pinenes obtainable from members of two distinct groups of Eucalypts are identical, and that the dextrorotatory pinene from the whole genus Eucalyptus, is a physical isomeride of the lævorotatory pinene (terebinthene) obtained from French oil of turpentine, and possibly also of the lævorotatory pinene of the Eucalypts, although this lævo form has, so far as observed, a higher specific rotation.

As phellandrene has not yet been detected in an Eucalyptus oil containing a highly dextrorotatory pinene, and as the opposite highly lævorotatory pinene has been found existing with phellandrene in several members of the Stringybark group of Eucalypts, it appears that we must arrive at the conclusion that the dextrorotatory pinene is present in greater abundance in Eucalyptus oils of the globulus type, and that are rich in eucalyptol, particularly as those oils are usually dextrorotatory, and eucalyptol having no rotation, the activity must necessarily be due to the terpenes. Although it had been assumed that terpenes having right and left rotation were probably present in these oils, yet, no proof had previously been forthcoming that this was so, and the isolation of

[1] Compt. rend. 1895, 120, 1417 – 1420.
[2] Comp. rend. 78, 788; 79, 314.

Digitized by Google

the corresponding lævorotatory pinene appears now to conclusively show that such is the case, and that we have existing in the oils of the Eucalypts two pinenes, one of which is probably the physical isomeride of the other.

By obtaining the nitrosochloride I have been able to detect the presence of pinene in nearly all the oils of the class of Eucalypts to which *E. globulus* belongs, such as *E. Bridgesiana*, *E. goniocalyx* etc., but it is only present in these oils in very small quantity, the greater portion of their constituents being terpenes other than pinene, and eucalyptol. The two species of Eucalyptus from which these present pinenes were obtained form part of a different group altogether from that to which *E. globulus* belongs. The Stringybarks are a group the investigation of whose oils has been of great assistance in extending our knowledge of the constituents of the oils of the genus.

Eucalyptol is almost entirely absent from the oils of the two species now under consideration, as it was only possible to detect its presence in the higher boiling portions, and even then it could not be detected by phosphoric acid, its presence in minute quantity being determined by iodol and also by bromine. Whether at other times of the year eucalyptol would be found to be present in greater quantity is of course a matter for future investigation.

On redistilling the oil from the Currawang Creek sample 63 per cent. was obtained between 156° and 162° C.[1] and 25 per cent. more distilled between 162° and 172° C. On distilling the oil from Barber's Creek under exactly the same conditions, 62 per cent. was obtained between 156° and 162° and 25 per cent. more between 162° and 172° C. These oils were practically identical, although the oil from the Barber's Creek sample was rather more dextrorotatory than that from Currawang Creek, but this difference might be expected, because our experiments show that the oils obtained from the trees of the same species growing together under exactly similar conditions have not the same rotation, but

[1] The temperatures given in this paper are all corrected, and stated to the nearest whole degree.

Digitized by Google

differ at times to a few degrees; constancy in optical rotation is not experienced in these oils. The oil from the Rylstone sample, rectified under exactly similar conditions, gave 60 per cent. between 157° and 164° C., and 28 per cent. more between 164° and 172° C., so that the temperature required to distil the lævo-rotatory pinene is a little higher than that necessary to distil the dextrorotatory form.

These oils, from the type species, are red in colour, which from their general appearance might indicate the presence of eucalyptol; it was a surprise to find an almost entire absence of that constituent.

The dextrorotatory pinene.

The leaves and terminal branchlets of *Eucalyptus dextropinea*, from Currawang Creek, collected and distilled early in August 1898, gave .0·825 per cent. of oil, or 100 lbs. of leaves gave 13¼ ounces. On rectification (after discarding the first two per cent. which came over below 156° C., and which contained but a minute quantity of aldehydes) the following results were obtained :—

63 per cent. distilled between 156 – 162° C. = first fraction
25 „ „ „ 162 – 172° C. = second fraction
Specific gravity, first fraction, at 17° C. = 0·8655
„ „ second „ „ = 0·8710
„ „ crude oil „ = 0·8743
„ rotation, first fraction + 38·18°
„ „ second „ + 36·34°

The leaves and branchlets of *E. dextropinea* from Barber's Creek, collected and distilled at end of July 1898, gave 0·850 per cent. of oil, or 100 lbs. gave 13¾ ounces. On rectification (after discarding the first two per cent. distilling below 156° C.) this sample of oil gave :—

62 per cent. distilling between 156° – 162° C. = first fraction
25 „ „ „ 162° – 172° C. = second fraction
Specific gravity, first fraction, at 17° C. = 0·8676
„ „ second „ „ = 0·8744
„ „ crude oil „ = 0·8763
„ rotation, first fraction, = + 39·59°
„ „ second „ = + 37·06°

Digitized by Google

From the above results it was apparent that the two samples might be considered identical oils, only varying to the same extent as is usually found with oils of the same species of Eucalyptus, at the same time of the year; the further investigation was, therefore, continued on the oil from the Barber's Creek sample alone. On again rectifying the first fraction of the oil from Barber's Creek (that portion boiling between 156° – 162° C.) the following results were obtained :—

28 per cent. distilled between 156° – 157° C. = first fraction
30 „ „ „ 157° – 158° C. = second fraction
23 „ „ „ 158° – 160° C. = third fraction
Remainder not distilled.

Specific gravity, first fraction at 18° C. = 0·8632
„ „ second „ „ = 0·8644
„ „ third „ „ = 0·8660
„ rotation, first fraction, = +40·43°
„ „ second „ = +40·08°
„ „ third „ = +39·03°

The third and final rectification, taking the fraction 156° – 158° C., gave 50 per cent. of an oil boiling between 156° – 157° C. This gave results as follows :—

Specific gravity at $\frac{4}{4}$° C. = 0·8750
„ „ $\frac{18}{18}$° C. = 0·8629

Specific rotation, using the specific gravity obtained at 18° C. = +41·2°

The boiling point of this dextrorotatory pinene may be stated at 156° C. and to have a specific rotation for sodium light +41·2°.

A sample of commercial dextrorotatory oil of turpentine containing the pinene Australene was rectified in the same apparatus and under exactly similar conditions, and using the same correction; 35 per cent. distilled between 156° – 157° C. This fraction had a specific gravity at 20° C. = 0·8624 and a specific rotation + 13·8°.

The lævorotatory pinene.

The leaves and branchlets of *Eucalyptus lævopinea*, collected by my colleague, Mr. R. T. Baker, at Rylstone in Aug. 1898, distilled

Digitized by Google

a few days afterwards, gave 0·66 per cent. of oil,[1] or 100 lbs. gave 10½ ounces. On rectification (after discarding two per cent. that came over below 157° C.) the following results were obtained :—

60 per cent. distilled between 157° – 164° C. = first fraction
28 „ „ „ 164° – 172° C. = second fraction
Specific gravity, first fraction, at 18° C. = 0·8676
„ „ second „ „ = 0·8725
„ „ crude oil „ = 0·8732
„ rotation, first fraction, – 46·74°
„ „ second „ – 44·3°

On again rectifying the first fraction (that portion distilling between 157° – 164° C.) the following results were obtained :—

42 per cent. distilled between 157° – 160° C. = first fraction
35 „ „ „ 160° – 164° C. = second fraction
Remainder not distilled.
Specific gravity first fraction at 19° C. = 0·8630
„ „ second „ „ = 0·8641
„ rotation, first fraction – 47·86
„ „ second „ – 47·38

The third and final rectification, again taking the first fraction, gave 50 per cent. of an oil boiling between 157° – 158° C. This gave results as follows :—

Specific gravity at $\frac{4}{4}$° C. = 0·8755
„ „ $\frac{15}{15}$° C. = 0·8626
Specific rotation taking density at 19° C. – 48·63.

The boiling point of this lævorotatory pinene may be stated to be 157° C. and the specific rotation for sodium light – 48·63°. This lævorotatory pinene thus boils at one degree higher temperature than the dextrorotatory form, and has a higher reverse rotation.

The same apparatus was used for the whole of the redistillations, and the results were obtained under exactly similar conditions, and upon the same quantity of oil. The redistillations were not

[1] This Eucalypt is known locally as "Silver Top Stringybark."

Digitized by Google

carried out under reduced pressure, so that they are strictly comparative. The temperatures given are those of the oil at the time the specific gravities were taken, and all are given against water at 16° C., except of course the determination of the pinenes at 4° C. The rotations were taken in a 200 mm. tube, the specific rotations being calculated from $\frac{a}{l.d}$ the temperatures of (d) being those stated in the paper.

On mixing equal volumes of the two pinenes, the rotation in the 200 mm. tube was $-6{\cdot}2°$ showing that the dextrototatory pinene had neutralised exactly the same amount of rotation of the lævorotatory form.

By referring to the results it will be seen that the specific gravities of the several fractions of the two oils, their rates of distillation and the percentage amounts distilling below 172° C. are fairly concordant, with the exception that the oil from *E. lævopinea* boils at a slightly higher temperature than that from *E. dextropinea*. The real difference between these Eucalyptus pinenes is their extreme opposite rotation, and while the specific rotation of the dextrorotatory Eucalyptus pinene is twice as great as that observed in the pinene (australene) from dextrorotatory oil of turpentine, the specific rotation of the lævorotatory Eucalyptus pinene is greater than that of the pinene (terebinthene) from lævorotatory oil of turpentine.

The Eucalyptus pinenes are identical in appearance, being colourless, mobile liquids, having an odour with a slight resemblance to ordinary oil of turpentine; the dextropinene has more markedly the odour of ordinary oil of turpentine than has the lævorotatory form.

The nitrosochlorides.

One volume of the pinene was added to one volume of amyl nitrite and the mixture dissolved in two volumes of glacial acetic acid; this was cooled in a freezing mixture of ice and salt, and concentrated hydrochloric acid and glacial acetic acid, in equal parts, slowly added while the blue colour remained; it was then

Digitized by Google

allowed to crystallise in the freezing mixture. The crystals from both forms were identical in every respect and melted quite sharply at 103° C. The product from the dextropinene was heated with alcoholic soda and the nitrosoterpene thus formed, when crystallised from alcohol, melted at 128° – 129° C.

The hydrates.

About four or five volumes of the pinenes were agitated for two or three days with one volume of nitric acid (sp. gr. 1·25) added to half its quantity of alcohol; the solutions were then allowed to slowly evaporate in open vessels. After some days fine crystals were formed in some quantity with both forms. These were rhombic crystals, and when purified by recrystallisation from alcohol, melted at 116° – 117° C. with elimination of water. On melting these terpene hydrates and taking the melting point of the terpenes thus formed, it was found that they both melted at 102° – 103° C. and that they both sublimed in crystals. The terpene hydrate from either form was soluble in boiling water, in alcohol and in ether; both behaved chemically in exactly the same manner in every respect.

A vapour density determination gave almost the identical figures required for the molecule $C_{10}H_{16}$.

The monohydrochloride was prepared from the dextropinene, this had the odour and appearance of ordinary camphor and melted at 123° – 124° C.

Crystalline tetrabromides could not be obtained by ordinary methods.

Polymerisation of the Oil.

A portion of the crude oil, *E. dextropinea* from Barber's Creek was treated with a very small quantity of sulphuric acid; much heat was generated, and the oil was much darkened. After the action was thought to be complete the product was well washed, dried, and distilled. It was then found that polymerisation had taken place, the boiling point of the oil being raised considerably. In the original crude oil from Barber's Creek there was obtained

Digitized by Google

on redistillation, no less than 77 per cent. below 165° C., (see table), whereas in the polymerised oil only 7 per cent. was obtained below 165° C., or tabulating the results:—

160° C.	to	162° C.	= 3	per cent.
162	„	165	= 7	„
165	„	167	= 25	„
167	„	172	= 58	„
172	„	178	= 64	„

The fraction obtained between 165° C. and 178° C. was found to have been reduced in rotatory power by about half. Originally the rotation for the whole fraction on the first distillation was +66·5° in a 200 mm. tube. After polymerisation of the oil the rotation in the same tube was + 32·3°. Evidently the polymerisation had not been complete.

From the results of the above determinations it is apparent that these Eucalyptus pinenes are chemically identical with terebenthene and australene, and only differ from them by having greater rotation. We thus arrive at the conclusion that the pinenes from the oils of the Eucalypts (N.O. Myrtaceæ), appear identical with those obtained from Pinus (N.O. Coniferæ).

As the Eucalyptus pinenes lend themselves so readily to polymerisation by acid, and as the crude oils from all the Eucalypts contain organic acids in some form, it is probable that certain constituents found in Eucalyptus oils are the result of a process of natural polymerisation of these pinenes in the oil cells of the leaf. It may be that eventually structural differences in the molecule may be determined between the Eucalyptus pinenes and those obtained from the Coniferæ, as indicated by the natural alteration products. Further research may decide this, but it does not appear that we shall receive much assistance from the preparation from these pinenes of known chemical compounds, because they, so far, have proved themselves identical with those obtained from the pinenes from the Coniferæ.

Digitized by Google

It may be well for the purpose of identification to retain specific names for these Eucalyptus pinenes, and as *Eucalyptene* stands for the dextropinene, I suggest the name *Eudesmene* for the lævorotatory pinene.

The discovery of Eucalyptus oils consisting principally of pinenes prevents the determination of sophistication of Eucalyptus oils with commercial oil of turpentine; if its presence was proved there is no reason why it should not have been obtained directly from Eucalyptus leaves, and need not have been the effect of adulteration. The necessity of determining the constituents of Eucalyptus oils to be used medicinally is thus again emphasized.

I wish to express my thanks to my colleague Mr. R. T. Baker, for botanical assistance in the preparation of this paper.

Digitized by Google

Table I., Results of the Oils of Both Species.

Crude Oil.		First Rectification.				Second Rectification.						Third Rectification—Pinenes.		
Percentage Yield.	Specific gravity, Crude Oil.	Specific gravity, first fraction.	$[a]_D$ first fraction.	Specific gravity, second fraction.	$[a]_D$ second fraction.	Specific gravity, first fraction.	$[a]_D$ first fraction.	Specific gravity, second fraction.	$[a]_D$ second fraction.	Specific gravity, third fraction.	$[a]_D$ third fraction.	Specific gravity, $\frac{4}{4}°$ C.	Specific gravity, $\frac{15°}{15°}$ C.	$[a]_D$ at 18° C.
					Eucalyptus dextropinea, Currawang Creek.									
0·825	0·8743 at 17°C.	0·8655 at 17°C.	+38·18°	0·8710 at 17°C.	+36·34°	...	...	...	...	...	...	...	...	...
					Eucalyptus dextropinea, Barber's Creek.									
0·850	0·8763 at 17°C.	0·8676 at 17°C.	+39·59°	0·8744 at 17°C.	+37·06°	0·8632 at 18°C.	+40·43°	0·8644 at 18°C.	+40·08°	0·866 at 18°C.	+39·03°	0·875	0·8629	+41·2°
					Eucalyptus lævopinea, Rylstone.									
0·66	0·8732 at 18°C.	0·8676 at 18°C.	−46·74°	0·8725 at 18°C.	−44·3°	0·863 at 19°C.	−47·86°	0·8641 at 19°C.	−47·38°	...	...	0·8755	0·8626 at 19°C.	−48·63° at 19°C.

Table II. gives the results of the redistillations of the crude oils of the two species of Eucalypts. Temperatures are corrected to the nearest whole degree. The results are percentages obtained from one temperature to another. The (*a*) denotes the commencement of the second fraction, the (*b*) that of the third fraction.

Below 156° C.	157	158	159	160	161	162	163	164	165	166	167	172	183	204
					Eucalyptus dextropinea, Currawang Creek.									
2	7	14	23	37	48	65	71(*a*)	75	79	83	85	90	93 (*b*)	96
					Eucalyptus dextropinea, Barber's Creek.									
2	7	13	22	34	46	64	70(*a*)	74	77	80	83	89	92 (*b*)	96
					Eucalyptus lævopinea, Rylstone.									
	Below 157° C. 2%	...	...	10	22	41	54	62	69 (*a*)	74	79	90	93 (*b*)	96

Digitized by Google

SOARING MACHINES.

By L. Hargrave.

[*Read before the Royal Society of N. S. Wales, November 2, 1898.*]

It is long since my diary contained sufficient matter to submit two papers in one year for publication in our Journal, but some late observations are of such a convincing nature as to the truth of the propositions enunciated here on August 4, 1897, that I trust you will permit me to advance the art of soaring another step.

Figures 1, 2, 3, show side and end elevations and plan of two soaring kites that are called M. and N. The following table is

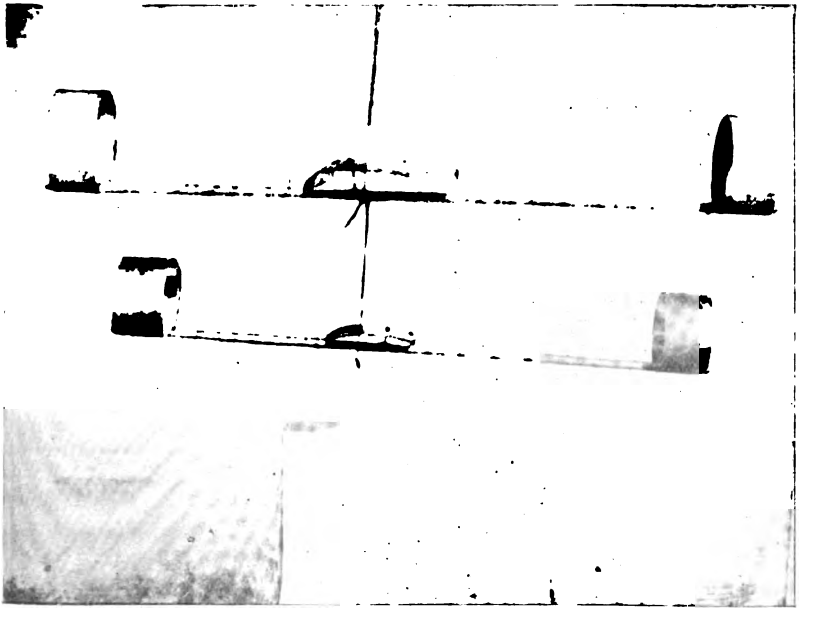


Fig. 1.

Digitized by Google

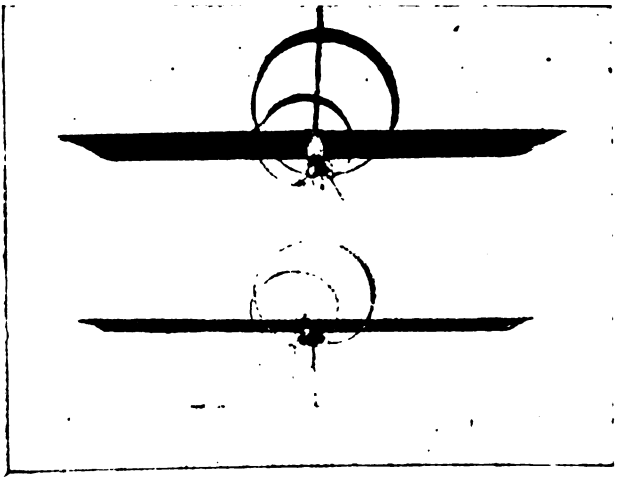


Fig. 2.

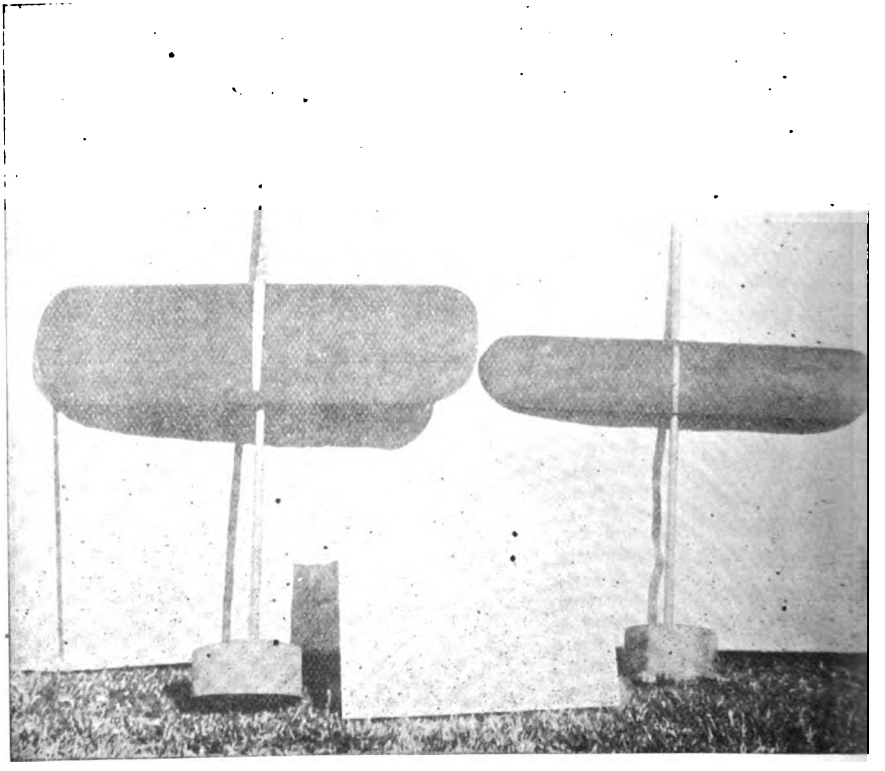


Fig. 3.

Digitized by Google

the type of the inscription that is plainly legible on the photographs but may be indistinct on the zincotypes :—

Soaring Kites.	M.	N.
Length	4′ 11″	4′ 11½″
Width	3′ 3¾″	3′ 0″
Projected area of propeller, square inches	371	243
„ „ end surfaces „	144	128
Total area, square feet	3·58	2·58
Weight, pounds	5·625	4·09
Weight per square foot, pounds... ...	1·57	1·59
Angle of propeller	− 4½°	− 3°

Both kites have repeatedly soared in wind with a velocity of ten to fifteen miles.

M and N differ in several ways from the vulcanite soaring kite described in the paper of June 1, 1898. The long tin tubes are much stiffer and the propellers are made of redwood. M also has a spring screwed to the front of its propeller so that a trial could be made with the propeller rigid followed immediately by one with the propeller springy. This showed the rigid propeller to be the best.

It is found that vulcanite immersed in boiling water and then bent does not retain permanently the curve imparted to it; neither does steamed wood unless nailed to numerous objectionable ribs. Bent metal plate is worse than bent wood and weight for weight is more flexible. There appeared no alternative but to work the curve of the propeller out of solid wood; this course produces with some patience the desired article. When the best curve has been decided on, curved wooden propellers will be produced by modern wood working machinery with as much facility as any form of moulding used in architecture.

A further consideration of the horizontal projection of a soaring bird's wing shows that the tip or flat part is approximately half the area of the soaring part.

When the wing is rigidly extended and the soaring part lifting properly; the tip, when in the plane of the true wind, will have

Digitized by Google

the relative wind acting on its upper surface, and be in effect a kite wrong side up.

The position of the tip, that is, whether it incline up or droop when viewed from front or rear, is a clear indication of whether the bird is soaring in a horizontal or downward blowing wind, or merely being supported by an upward trend of wind.

The albatross and frigate bird show the drooping tip to perfection. Hawks and eagles frequently show the upward bent tip, and when they do so we may safely conclude that any flat object would be up-borne by the wind in their neighbourhood. Birds that circle in calm or nearly calm air, have the wing tips turned up; and if the performance takes place over a hot and dusty plain, the conditions are favourable for the formation of a sand column or "whirley." The bird that soars in a gale has a deeper concavity of wing than the one that soars in a moderate breeze, from which I deduce that the velocity of rotation of the vortex must have some point of maximum efficiency. In other words, the small vortex cannot attain an infinite velocity, and the large vortex loses its efficiency when its speed of revolution is reduced below a certain point. Each form of soaring wing is evolved by the average velocity of wind in the latitudes frequented by the bird.

A kite (O.) was made four feet wide and seven inches in a fore and aft direction. Two feet six inches of the middle was shaped to a soaring curve and the rest left flat. The inclination of the flat part to the chord of the soaring part was 5° and unadjustable. A rod with weighted ends and small tail was added. This kite soared several times but was crank athwartships.

It was thought desirable to reject all horizontal surfaces as it appeared that their only use to a bird was to enable it to fly when there was no wind; and as these soaring kites had no motor but the soaring curve, the flat surfaces only increased the drift. At this point the soaring machine develops into a form that has no counterpart in nature. The rod now having no horizontal surface at the ends; could not, by the inertia of the lead weights alone,

Digitized by Google

long retain the propeller at the proper soaring angle. The machine must sooner or later tip either up or down. The rod with loaded ends and cells can but retard the end tipping long enough to show that the propeller is soaring. For these reasons the weight was transferred to a point below the propeller, thus reverting to the method of maintaining the equilibrium of the balloon or parachute, and which is used by the experimenters with gliding machines.

The situation and aspect of the tail or weather-cock came under consideration, and it was seen that the nearer it was placed to the after edge of the propeller the more instantaneously would gravity adjust the propeller to the proper angle. It was also recognized that whatever area is given to the weathercock, its longest dimension should be vertical. The meteorologists will think this rank heresy.

Lancaster points out that the weather-cock should be vertical only; and as far as I know every aeronautical construction ever made but his, has horizontal tail surface. A moment's consideration should have shown us that when we wish to preserve the angle of incidence by the action of gravity, as all gliding machines do, any horizontal tail must act as a check to the necessary rapid adjustment.

Kites M. and N. were therefore remade as shown in Figs. 4, 5, 6, 7, and assume a strong likeness to Lancaster's "effigy" described in the *Engineer* 1882, and which I have endeavoured to reproduce in Fig. 8, from his dimensions given in Chanute's "Progress in Flying Machines," page 199. I can well believe that many of Lancaster's "hundreds of effigies" soared in spite of their flat cardboard surfaces, *if* the stick that extended the wings had some considerable depth and was fastened to the under side of the front edge; which point is not made clear.

It is also recorded in the same work at page 197, that his explanation in the *American Naturalist* was so plainly erroneous that he was harshly criticised.

Digitized by Google

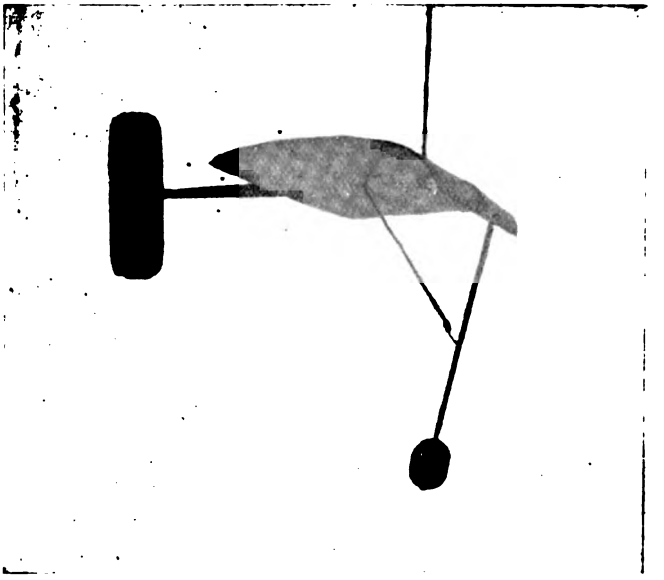


Fig. 4.

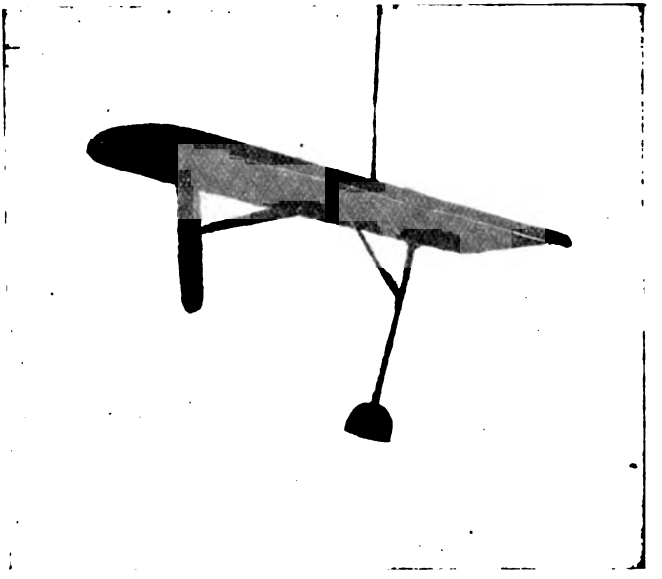


Fig. 5.

Digitized by Google

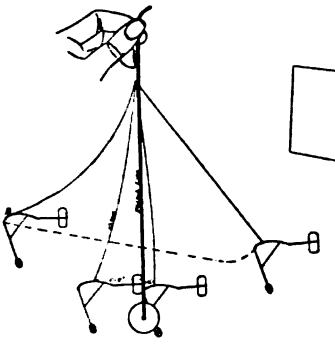


Fig. 9.

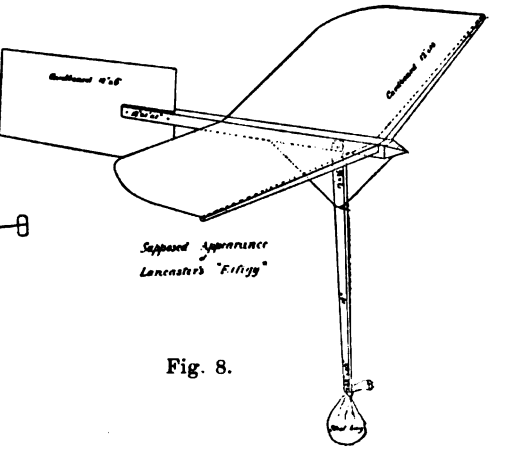


Fig. 8.

I think that Le Bris in 1867, Mouillard (date unknown), and Lancaster in 1882 all made soaring machines that worked by means of the soaring vortex, although there is no record of their having known or shown that the air in contact with the rear side of the leading edge was at a higher pressure than that on the windward side.

Phillips in 1884 and Montgomery (date unknown) showed that the air at the rear of the front edge of a similar curve to a soaring bird's wing was moving downwards, but both of them just stopped short of finding out the high pressure of the vortex.

Lilienthal found that arched surfaces produced a lift slightly to windward of the zenith, my work published in 1893 being identical with this.

If there are others who have made soaring machines and showed why they soared, I have omitted to mention them through ignorance, but in a matter concerning claim to priority of discovery the credit must go to the man who first publishes his knowledge, and none at all to the one who knew and withheld his information with a view to exploiting humanity.

Digitized by Google

I have noticed that soaring is easier in a wind velocity that is increasing than when it is decreasing, and attribute this to volumes of air of high density and velocity driving in under volumes of lower density and velocity: the contiguous surfaces will then cause eddies in the combined mass rotating in the same direction that the soaring vortex does: that is, the upper part of the eddy moving to windward and the lower part to leeward, one of these would be more readily caught and held by the propeller than when the contrary conditions prevail.

Every detail of Kites M and N as remodelled are shown in Figs. 6, 7, and they now contain all the necessary parts of a practicable soaring machine to carry one man, and I expect to hear ere this is in print, that some of the gliding machines on the shore of Lake Michigan have been fitted with soaring curves, the trials of which are certain to be successful.

The observations made on August 31, 1898 are as follows:— Kites M and N to the beach. Very steady east wind, twelve to

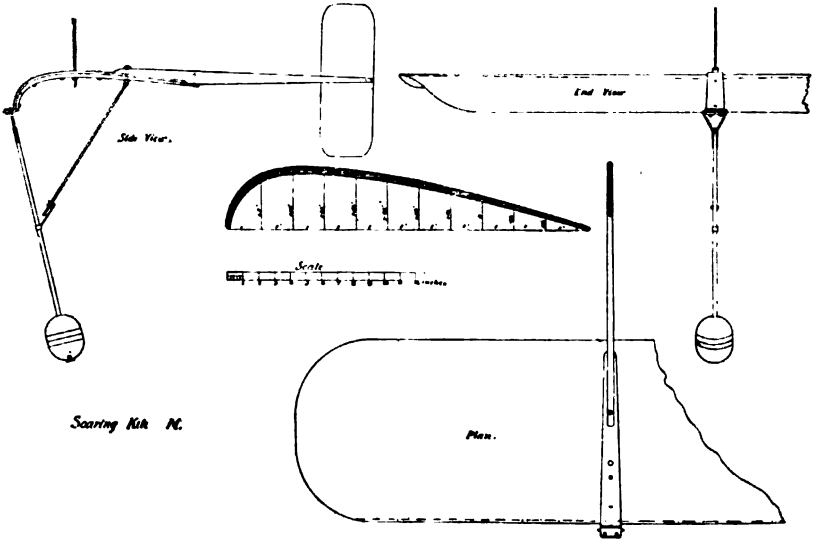


Fig. 6.

Digitized by Google

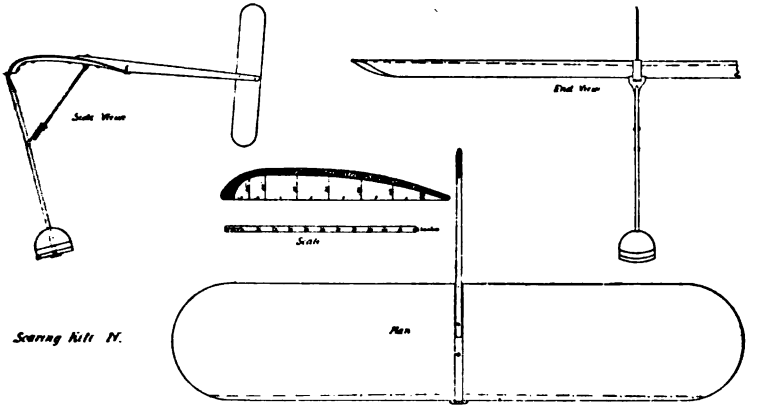


Fig. 7.

fourteen miles. No sea to speak of or that might cause large pulsations in the wind. Poles placed close to the water. The waves washed round the two windward pegs. Sand almost level. Rain beating the models down.

Kite M hung by thirteen feet of cord ·15″ diameter = 23 sq. ins. of cord for head resistance.

Kite weighs without ballast 1 lb. 12 oz.
Ballast 3 lb. 1 oz.

Total weight 4 lbs. 13 oz. = 4·81 lbs.

Projected area of propeller 2·58 square feet.
Load = 1·86 lbs. per square foot.

When M was loaded with 3 lbs. 1 oz. of lead she hung persistently 7° to windward of a plumb line passing through the after end of the tail and the knot that attaches the hanging cord to the horizontal one at the top of the poles. Sometimes she would swing back till the hanging cord was from one to two degrees out of plumb. The plumb line and weight were sheltered as much as possible from the wind by my arm.

When the kite is drawn about four feet back from the vertical position and released, the hanging cord slacks when the kite has

Digitized by Google

swung about two feet forward, and M soars with a deep bight in the cord to position B (Fig. 9), and then turns and rushes round like a conical pendulum, jerking savagely at the hanging cord in all directions. It then has to be caught as it is impossible to tell what is real soaring and what is impulse derived from elasticity of the poles and cords.

Kite N was then attached to the horizontal cord by a piece of fishing line and loaded with 2 lbs. of lead.

The area of N's propeller is 243 square inches = 1·69 square feet
N's weight without lead 1 lb. 0¼ oz.
Lead weights 2 lbs. 0 oz.

3 lbs. 0¼ oz. = 3·016 lbs.

Weight per square foot = 1·78 lbs.

Kite N starts from a plumb position and ascends slowly at an angle of about 45° to windward, it did it five or six times in spite of the rain beating it down, and the drift of the hanging string and a light line tied to the weight to keep it from dashing about. Fig. 9 shows a side view of the experiments with M.

It may be thought that it would be more conclusive if the models were allowed perfect freedom. This matter has not escaped consideration, and the reasons for not working with free apparatus at present still hold good. By using the captive method, any amount of skill and patience expended in the manufacture of the soaring machine is amply repaid by its possession and the knowledge that the experiment can be repeated under similar conditions. Whereas if the free method is used, a form that merely wanted a little adjustment to be perfect, would frequently be smashed or lost in the sea without anything remaining to show its defects or lead to rapid improvement.

Of course if I lived in the centre of a sandy plain, with numerous assistants to make and repair constructions of my design, certain advantages would accrue, but at present I try to make the utmost use of the facilities at my disposal.

Digitized by Google

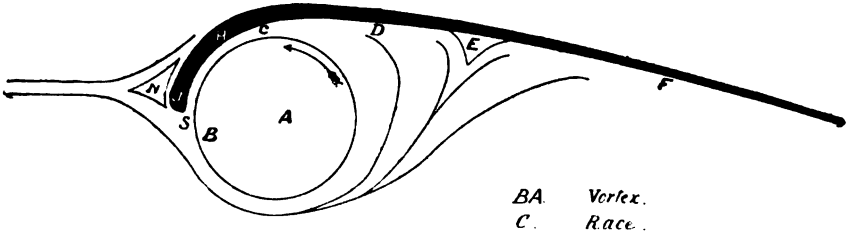


Fig. 10.

BA.	*Vortex.*
C.	*Race.*
D.	*Guide.*
E.	*Divide.*
F.	*Kite surface.*
H.	*Vortex Nest.*
J.	*Hook.*
N.	*Dead Air.*
S.	*Discharge.*

Fig. 10 shows the condition of the air in the neighbourhood of the soaring curve and the following statements may help us to arrive at the exact power developed :—

1. The hook originates the vortex.

2. The diameter of the vortex is determined by the radius of the race.

3. The velocity of rotation is something less than the velocity of the wind or relative wind, and is maintained thereby. If the wind is thirteen miles and the curve advances into the wind at one mile, the relative wind is fourteen miles and the velocity of rotation about 2,600 revolutions per minute.

4. The air drawn in from the rear of the vortex rises in pressure as the race contracts.

5. The high pressure air in the race acts on the soaring machine by thrust on the vortex nest.

6. The vortex cannot increase in diameter or burst because the vacuum at the centre is of the exact tenuity that balances the centrifugal force of the particles of air forming the vortex.

7. If the head resistance of the soaring machine is decreased by a lull in the wind, the air in the race expands leaving the vortex slightly to leeward, that is practically increasing the radius of the vortex nest, the vortex then increases in diameter and

Digitized by Google

rotates slower, draws in less air past the guide and restores the equilibrium.

8. Some of the discharge from the race may pass into the dead air to windward of the hook and so over the top of the soaring curve, or if the dead air space is filled up solid with part of the material of the soaring curve the whole discharge is carried under the vortex and may or may not be drawn in again between the vortex and the guide. The discharge cannot mingle with the air of the vortex, as every circumferential particle of its air is held at a fixed distance from the centre by the tenuity of the vacuum.

9. The lower front quadrant does not add to the head resistance as it is rotating to leeward nearly as fast as the relative wind.

10. The after part of the soaring curve if it extends to leeward of the divide acts as an aero-curve.

On October 20, 1898, the wind was about seventeen miles per hour, and it was found that Kite N could be loaded with lead to a total weight of 3·6 lbs. on 1·69 square feet = 2·13 lbs. per square foot, and that when so loaded it would rise at an angle of 70° or 80° to windward until it was fifteen feet from the sand, it then got into wind of greater velocity and drifted to leeward. Here I am confronted with a difficulty that at present is unsurmountable. Either the soaring machine must be started from such a height that the weight can be approximately adjusted to the existing wind; or, the weight must automatically adjust the negative angle of the propeller as the wind increases.

Kites O (Figs. 11, 12), P (Fig. 13), Q (Fig. 14) have a different system of adjustment and suspension of the weight. A piece of $\frac{3}{4}''$ tube is secured rigidly to the propeller and nearly parallel to its chord. The connection between the tube and propeller in O and Q is a steel plate $1\frac{3}{8}'' \times \frac{1}{16}''$ and long enough to keep the weight at the required distance below the propeller. The weights are lead cylinders $\frac{3}{4}''$ diameter and about $1\frac{1}{2}''$ long. A sufficient number are strung on a $\frac{1}{8}''$ wire. The adjustment of the position of the weight is effected by pushing the string of weights in or

Digitized by Google

out of the tube. The head resistance is thus reduced to that of the edge of the plate plus the end area of the tube.

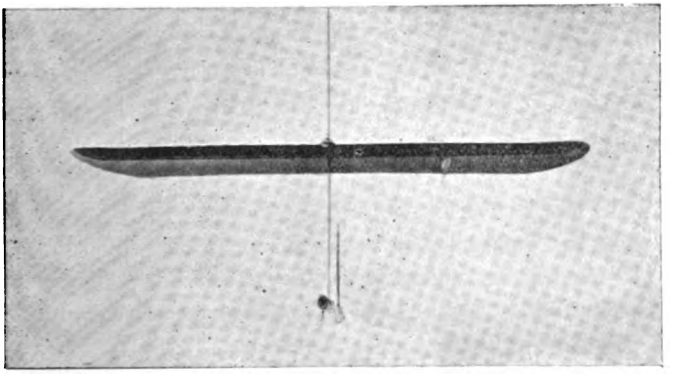


Fig. 11.

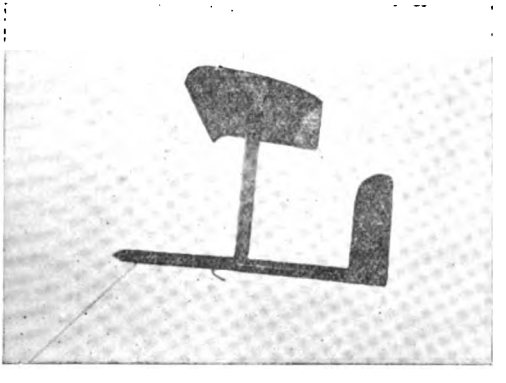


Fig. 12.

Kite O has the weather cock attached to the after end of the tube, and is the kite previously mentioned, now remade.

Kite P has the upper side quite flat, the hook is 3″ abaft the sharp leading edge of the propeller. The space between the hook and the leading edge of the propeller is solid wood slightly concave, so that there can be no dead air to windward of the hook.

Digitized by Google

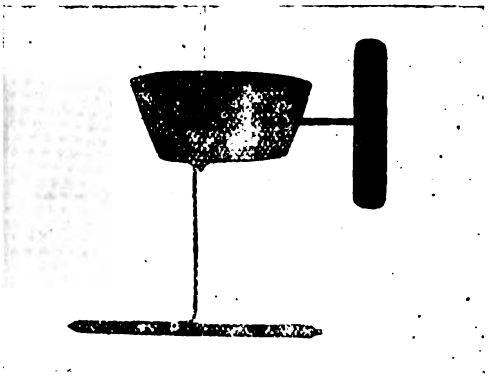


Fig. 13.

A fringe of silk is glued to the concave side of the propeller on O and P so that it is possible to see that the "divide" is approximately in the position shown in the diagram (Fig. 10).

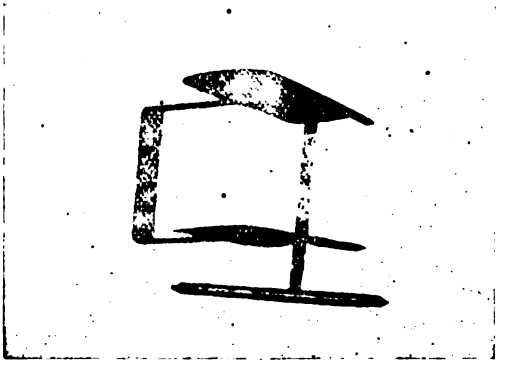


Fig. 14.

Kite Q has two propellers superposed at a distance of 8″. The ballast tube is $3\frac{1}{4}$″ below the under one. This kite shows that a double propeller soaring machine can be balanced in a fore and aft direction as well as, or better than, the single form.

Digitized by Google

NATIVE VOCABULARY OF MISCELLANEOUS NEW SOUTH WALES OBJECTS.

By MR. SURVEYOR LARMER.

(Communicated by Professor T. P. Anderson Stuart, M.D., by permission of the Honourable the Secretary for Lands.)

[*Read before the Royal Society of N. S. Wales, November 2, 1898.*]

THE following letter is explanatory of the paper :—

"21st October, 1898.

Sir,

In compliance with the request contained in your letter of the 8th instant, I have the honor to forward herewith a copy of "Larmer's Native Vocabulary," and to inform you that there is no objection to its being printed in the Society's Proceedings, as proposed.

"It may be of interest to learn that the late Mr. J. Larmer was employed by the Government of New South Wales in the capacity of Surveyor, and bore a very high reputation as an efficient and reliable officer, as evidenced by his long term of over thirty years service, ranging from 1829 to 1860, and the importance of the surveys entrusted to him, some of which are enumerated hereunder. Although, during the period mentioned, Mr. Larmer carried out many surveys in the Counties of Cumberland and Northumberland, he was chiefly engaged in the vicinity of Sydney.

"Surveys of the Coast between Sydney and Botany, portion of George's River, Botany Bay and adjacent country, the Hawkesbury River, the Dividing Range. Surveys around Parramatta, Lane Cove, Willoughby, Gordon, Neutral Bay, etc."

I have the honour to be Sir,
Your obedient servant,
W. HOUSTON,
Under Secretary.

Professor T. P. Anderson Stuart, M.D.,
University of Sydney."

Digitized by Google

LARMER'S NATIVE VOCABULARY.

(Transmitted 24th November, 1853.)

(1834)

Brisbane Water and Tuggera Beach Lakes.

Nurroo.	Black	Jebug.gall. or Goen.	The Devil
Burrung.	White	Chullora.	Flour
Ber. ral.	Hard	Jungal. maboo	Shout again
Kin. yut.	Soft	Bung. hi.	To-day
Nä. bä	Tomahawk	Warra.	Yesterday
Bab. ba. loo.	Tobacco pipe	Indore.	You
Gerri. barra.	Musket	Attore.	Me
Tudera	Kill	Gurranang.	Sugar
Kurrawan	Smoke	Cud.yel.	Tobacco
Win. di. gi.	Messmate	Warrah.	Start—go
Bur. ri. bi.	Husband	Ki.	Come
Nugung.	Wife	Guyong.	Fire
Kooranung	Honey	Ba-rdo.	Water
Yurragun.	Hungry	Bolbi.	Wood
Pott.oo	Water	Coo. je. la.	Knife
Kurrawa.yong.ah.	Smooth sea	Mar. ra.	Take it
Kurrawa.tulgan.	Rough sea	Attore weha	I gave
Coorey.	Blackfellow	Attore. wine. bung. nine	I want it
Indore. wėä	You tell	Cundoo.	Bread
Girrumbullong	Whitefellow	Muggoo. ruggoo.	Fish
Yandee. andee.	Run	Ki. balee.	Come along
Wannung. garri. bee.	Where are you	Burril.	Money
Tugga.	Eat it	Wanderingabee. hoowine.	Where are you going
Narra. becha.	Drink more		
Muttong.	Courageous		

Hunter's River.

Urroong. ah.	Run, make haste	You. ring.	Go

Hunter's River, Brisbane Water and Newcastle.

Wog. wool.	One	Gow. way.	Throw it away
Pulwarra.	Two	Manna.	Take it
Ur. roo.	Three	Bonna.	South
Cow. woy.	Four	Sonda.	North
Warrangal	Five	Joog. a. ra.	North-east wind
Gum. mi.	Spear	Beambolong.	Large
Mutting	Fish-spear	Cullan. gulong.	Long way off
Gin. ga.	Frightened	Yerring.	Whiskers
Ki. kupa.	Come along	Wongul.	Deaf
Mir.ree.	Dog	Kuriwa	The sea
Murroon	Good		

Digitized by Google

Nye	Mother
Be. ung.	Father
Bung. hi.	Brother
Hurreen.	Sister
Cowan.	Uncle
Nurrung. yan.	Old woman
Cow. wow.	Yes
Cow. way.	No
Coo. ning	Small
Ur. roong.	Large
Thirty.	Dead
Murroon	Living
Nullural.	Wet
Boo. rurra.	Dry
Minning	Night
Burre. ung.	Daylight
Mimmi	To-morrow
Coolla.	Mouth
Yumree.	Hand
Mundow. ay.	Foot
Neu. gro.	Nose
Binna	Ear
Pun. yal.	The sun
Yun. a. ga.	The moon
Worree. worrung.	Stupid fellow
Murroong.	Good
Wejung	Bad
Gow. lang.	The stars
Tug. ge. ra.	Cold
Mur. ro. ree.	Warm
Nungara.	Sleep
Tulgan	Heavy swell
Nung. ha.	Smooth water
Wib. bee.	Wind
Eu. dra.	Clouds
Murree.	Wolobi
Warral.	Sit down
Cobbo.	Stop
Muttama	Take it
Gurra. gurran.	Grog
Indore. we. ah.	Yo(u) tell
Bunnung. ga. ree.	Boat

Bateman's Bay.

Go.en or Cobboba	The Devil
Bug. green.	The sun
Towara.	The moon
Gin. gee.	Stars
Mungaroo.	Clouds
Boo. mo. ah.	Thunder
Thundala.	Lightning
Kooroo. gama.	Wind
Bunna.	Rain
Tuckite	Frost
Wad thung	Grass
Boora.	Rock
Kuna. ma.	Snow
Burleen.	Salt-water
Nad. jung	Fresh-water
Mud ja ree	Canoe
Tugga	Cold
Kulla.	Warm
Mangara.	Bark
Tugga. e. lee.	No
Nài.	Yes
Fajoworoo.	Hair
Koondoo.	Head
Era.	Tooth
Ta (or) Tha.	Mouth
Wil. lee.	Lip
Binjee	Belly
Munna.	Hand
Kooree.	Ear
Thun. na.	Foot
Mubbara	Eyes
Narree.	Leg
Boo. roo.	Kangaroo
Birre. bine	Emu
Mugga.	Snake
Tag·ula.	Pheasant
Murrera.	Whale
Warang.	Boy
Muln. a.	Girl
Bejea	Old man
Moolootha.	Old woman
Eurong. a.	Young man

Digitized by Google

Booraja	Morning	Ullung. brotha	Five
Boo. goo. ya.	Sun set	Muno. al.	Ten
Tub. ba. ra.	Night	Mundaja	Meat
Mena.	What	Tung. ah.	Bread
W.abine	Go	Mirrega	Dog
Ya. woi.	Come here	Burral	Wolloby
Boo. ee.	Make haste	Murraba.	Kangaroo
Miare	Sit down	Koong. a. ra.	Opossum
Purdoo.	Foot path	Mar. rah.	Fish
Mundaba.	Tomahawk	Nadjára	Canoe
Tugon.	Hut	Yarramun	Horse
Currung. adeta	Grog	Bid. doo.	High range
Moorh	Tobacco	Innull-nurrowan.	Flat Country
Tundulla.	Small	Bud. da.	Creek
Birrega	Large	Duro. ya.	River
You. een.	Blackfellow	Cog. goo.	Gully
Jirrung. galá.	Whitefellow	Kurraloo.	Monkey
Win. gun.	Black Gin	Jag. goola.	Pheasant
Mitta. la. lee.	One	Bun-goo.	Squirrell
Mung. ung. dara.	Two	Woom. barra	Duck
Toorung. gow. aree.	Three	Jumaga.	Good
Muna. linga.	Four	Cor.ne.na.	Bad

Ulladulla.

Tug. gi	No	Koona.	Duck
Nawa.	Yes	Ka. an. dee.	Tobacco
Yi.	Come	Yan. yee.	Fire
Wob. a. ra.	Go	Boonbal.	Wood
Wonaga-wey. ou.	What is your name	Warrang.	Child
		Niara	Look there
Tung. ah.	Bread	Tookun (or) Coonjee	Hut
Mondagai	Meat	Cumboo. gullock	Bullock
Mar. rah.	Fish	Eu. roka.	The sun
Burroo.	Kangaroo	Judcho.	The moon

Braidwood.

Yarra. bunye.	Go away	Murring	Blackfellow
Jou. woi.	Come here	Kooralala.	Whitefellow
Mun. numalee.	Make haste	Kooroo.bun.	Rock
Nulla (or) Bimbal	Wood	Bullon	Black Gin
Nadjung	Fresh-water	Nung. lee	Beef
Cadthung.	Salt-water	Tithijung	Bread
Woodthung	Grass	Bullinjan	Grog
Bondung.	Rain		
Kooroo.gama.	Wind	Mittung	One
Koolumbroo.	Cloud	Bullalla	Two
Jerrung.	Star	Bullamatung	Three
Jad. jung	Moon	Nerang.	Four

Digitized by Google

Yeo Yeo and Narraburra.

Murrumbung.	Good	Bo.gin	Grass
Ingil	Bad	Towara.	Wind
Oonbi	One	Me. ma.	Star
Bulla	Two	Dowin	Tomahawk
Bullongaubee	Three	Doo. loo.	Spear
Moddoo.	Four	Burgan.	Boomerang
Oog. goo. e	Five	Mulyan.	Eagle Hawk
Gib. bre. bung	Ten		
Wallung.	Rock	Jin.nung	Foot
Eu.rung.	Rain	Murra.	Hand
Ge. wong.	Moon	Mill	Eye
E. rae	Sun	Nun.	Mouth
Pudthaubung.	Duck	Bullong.	Head
Moonda.	Native Dog	Boorabin	Belly
Eurong.	Emu	Wood. da.	Ear
Comboll.	Turkey	Mo. roo.	Nose
Guya.	Fish	Dalline	Tougue
Tambaree	Water mole	Moo. nil	Old
Mi. eeu	Blackfellow	Boo. bi.	Young
Iu. nur.	Gin	Dundong.	Cold
Boo. ri	Boy	Woo. gil	Warm
We e. in	Fire		

Upper Calara or Lachlan.

O.gill	Warm	Dundoo.	Swan
Mumbo. a.	Hot	Booralgal	Native Companion
Tog. ge. ra.	Cold		
Calleen	Fresh-water	Toon. gool	Bear
Boog. woo. in	Grass	Wirreet	Wind
Ur. roong.	Emu	Weri	No
Wamboo. een	Kangaroo	Now. a.	Yes
Ku. ya.	Fish	Yantagee	Go
Coom. bull	Turkey	W'e.ja	Stop

Junction of Lachlan and Murrumbidgee.

Muccara	Rain	Bick. nunna	Old man
Wilya	Hot	Brung. ine	Emu
Tillal	Cold	Boolooka.	Kangaroo
It. tha	No	Ka. en.	Dog
Ye. a.	Yes	Toolombee.	Duck
Nicka	Go	Burri. mully	Good
Go. woi	Come	Mummothinthy	Bad
Nun. na.	Blackfellow	Mow.a	One
Birrup	Gin	Eu. rowal	Two
Ballite	Boy	Thur. a. lu. a.	Three

Digitized by Google

Dinnewa	Four	Na. eng. hee.	Sun
Curra.	Five	Too. rt-tee	Star
		Willong. he	Wind
Menino.	Make haste	Mug. ga. ree	Rain
Nau. ga. mo.	Stop	Tenangee	Cold
Wine. got. by	Moon	Kel. lal. lee	Warm

Transmitted to the Surveyor General, November 24th, 1853.

JAS. LARMER.

A small plain at the crossing of the road from Murringo to Bathurst on the Lachlan is called "Mulyan," in consequence of Eagle Hawks frequenting it formerly.

At all the stations, the names ending in "ong"—Jallong, Curiong, Illalong, Bogolong, Bennelong, there are ponds and springs of permanent water.

At Dumondril large weeds grew previous to its occupation by the whites from which the natives made spears.

At Mr. Broughton's Station on the Burrowa River, is a large and very deep water hole called "Binjenine." Binge in that neighbourhood is a word applied to the stomach by the natives.

JAS. L.

Native names of Points of Land in Port Jackson (South Shore).

Long Nose Point	Yerroulbin
Goat Island	Milmil
Jack the Millers Point	Coodye
Slaughter House Point	Tárrá
Bennelong Point	Jubughalee
Mrs. Macquarie's Point	Yourong.
Elizabeth Point	Jerrowan
Mr. McLeay's Point	Yarrandab
Point Piper	Willárrá
Rocky Point (South of Vaucluse)	Burrowwo.
Vaucluse Point	Móring
Siddons and Watsons	Kutti.
Lang's Point	Ku-bung hárrá

Digitized by Google

Sow and Pigs	Birrur bir-[1]
Shark Island	Boam bill-[1]
Clark Island	Billong-ololah.

Native names of Points of Land, North Shore of Port Jackson.

Billy Blues Point	Warung áréá.
Hulk Bay	Quibéreé
Milson's Point	Kiarabilli
Point East of Milsons	Wudyong.
McLarens Store	Wurru-birri
Careening Cove Head	Wéyé Wéyé
Point West of Robertsons	Kurrá bá
Robertson's Point	Wulworrá-jeung
Mossmans Whaling Establishment Sirius Cove	Goram bullagong.
Bradley's Head	Búrroggy
Chowder Bay	Koreé
West Head	Gurugal.
Middle Harbour	Warrin gá
North Harbour	Kun'-ná
Fincham's, North Harbour or Balgowlah Township	Jilling
Darling Harbour	Tumbulong.
The Spit, Middle Harbour	Burra-brú
Point East of Spit	Parriwi

J. LARMER,

September, 1832.

[1] Word incomplete, mutilated in binding.

Digitized by Google

CURRENT PAPERS No. 3.

By H. C. RUSSELL, B.A., C.M.G., F.R.S.

[With Plates X., XI.]

[*Read before the Royal Society of N. S. Wales, October 5, 1898.*]

IN two previous papers, I have recorded two hundred current papers and this paper adds another one hundred and sixty-seven to my list. The first list contained forty-three papers which had come to me direct. The second list contained one hundred and fifty-seven, of which ninety-three had come to me direct, and sixty-four were given to me for publication. Since the publication of the second list, the papers which follow have come in, and many of them are of great interest. These three essays have been published at intervals of two years; the first on October 9, 1894, the second on September 2, 1896, and this one on October 5, 1898. During the past two years north-west winds have been very prevalent, and they are always a hindrance to the receipt of current papers, because they blow them away from the south coast of Australia.

Reference was made in No. 2 pamphlet to the rapid drift 16·8 miles per day in the Indian Ocean of current paper No. 56. This time we have seven papers in that sea, and their average rate of drift is 12·2 miles per day, and one No. 258 made 16·9 miles per day; probably with all these papers there was considerable delay in reporting the finding of them.

It may be mentioned here, that in the Indian Ocean the rate of drift falls off rapidly going north to the equator; and north of the equator the drift is towards the west.

In the following charts each current paper track has in addition to its number the daily rate of drift which the paper made, and the experience gained with this lot of papers bears out that of No. 2 essay, viz., that the rate of drift increases as you go south

Digitized by Google

from Lat. 30° S., and No. 217 in Lat. 47·16 S., made the greatest on record there, 12·4 miles per day.

Taking the dates at which they were found as the order of arrangement, it appears that the papers received were not evenly distributed over the months, but generally there are more in the winter months when southerly winds prevail than in other times in the year; see the following table showing the number received

MONTHS IN WHICH CURRENT PAPERS WERE FOUND.

1896

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
/	...	...	...	/	/	...	/	/	/	/	/	
...	...	...	...	...	...	...	...	...	/	/	/	
...	...	...	...	...	...	...	...	...	/	/	/	
...	...	...	...	...	...	...	...	...	..	/	/	
...	...	...	...	...	.	...	...	...	...	/	/	
...	...	...	...	...	...	...	...	...	...	/	/	
...	...	...	...	...	...	...	...	...	...	/	/	
...	...	...	...	...	...	...	...	...	...	...	/	
...	...	...	...	...	...	...	...	...	...	...	/	
...	...	...	...	...	...	...	...	...	...	...	/	
1	...	...	...	1	1	...	1	1	3	7	11	—Total 26

1897

/	/	/	/	/	/	/	/	/	/	/	/	
/	/	/	/	/	/	/	/	/	/	/	/	
/	/	/	/	/	/	/	/	/	/	/	/	
/	/	/	/	/	/	/	/	...	/	/	/	
/	/	...	/	/	/	/	/	...	/	/	/	
...	/	...	...	/	/	/	/	...	/	/	...	
...	/	...	...	/	/	/	/	...	/	/	...	
...	...	...	...	/	...	/	/	...	/	/	...	
...	..	...	...	/	...	/	/	...	...	/	...	
...	...	...	...	/	...	...	...	...	...	..	...	
5	7	4	5	10	7	9	9	3	8	9	5	—Total 81

1898

/	/	/	/	/	/	/	/	/	/	/	...	
/	/	/	/	/	/	/	/	/	/	/	...	
/	/	/	...	/	/	/	/	/	/	...	...	
/	/	/	...	/	/	/	/	/	/	...	...	
...	/	/	...	/	/	/	/	...	/	...	...	
...	...	/	...	/	/	...	/	...	/	...	...	
...	...	...	...	/	/	...	/	...	/	...	...	
...	...	...	...	/	...	...	/	...	/////	...	...	
4	5	6	2	8	7	5	8	4	12	2	...	—Total 63

Digitized by Google

each month. In October 1896 the number was small, it increased in November and December, fell off in January 1897, increased in February, fell off again to another minimum in March, when only four were received. In May, June, July and August there were many current papers, ranging from seven to ten in the month. In September the number again fell away and only three were received, October brought an increase, and November nine papers, again they fell off with the north-west winds. May 1898 brought ten papers, and in June, July, and August we had many papers. In September they again fell off with north-west winds. The foregoing tabular statement shews this more in detail.

It is of course impossible to see which way these papers cross the sea, and it has been pointed out before that the line given is the shortest way convenient for the draftsman, and the speed is calculated along that line. As the ocean current south of Lat. 30° sets nearly due east, and the average direction of the papers is east-north-east, there can, I think, be no question that they are carried northward by the prevalent winds, and if the winds came from north-west they are carried away from the coast instead of towards it. Hence the receipt of current papers decreases with north-west winds.

I have been often asked, what percentage of the papers thrown over come back to me? At present it is impossible to give a definite answer to that question, for several reasons: first, although I know how many papers I send out, I do not get any return of the number set afloat; and second, probably some vessels do not set any afloat. It is obvious therefore, that no definite answer can be given to the question.

There is a good prospect for any paper reaching the coasts of Western Australia, South Australia, Victoria, or New South Wales, and the North Island of New Zealand, coming back to me, but very little for one landing on the west of Tasmania, or the west coast of Middle Island of New Zealand, because the coasts are rugged and have few inhabitants, and many other places such as

Digitized by Google

the south coast of Asia generally, and west coast of Africa, from which the return of the papers which may be cast on the shore is improbable. I get papers from these places only occasionally. One of the dangers which beset current papers has become evident recently and that is, sometimes the finder of the bottle thinks it of more value than the paper inside of it.

Although a definite answer to the question what percentage of the papers come back cannot be given, my impression is that five or six per cent. of those thrown over in Australian waters came back to me, and probably eight or ten per cent. go on shore outside Australia and are never heard of.

Twenty-four per cent. of the papers that do come back have been thrown over when the vessels were only a few miles from the shore, and there is good reason to believe that they go on shore at once, because there is such a short interval between the throwing over and the finding. Since the land is generally much warmer than the water, it produces an indraught from the sea which is most effective close in shore and probably has much to do with taking the bottle-papers on shore.

It is very unusual for a paper thrown over close in shore to be carried away to a distance, but I do get a few that have drifted into the open ocean to find a resting place on distant land. On October 31st, 1896, when the *Ormuz* was in Lat. 37° 17′ S. and three miles off the coast, a current paper No. 229, was thrown over at 10 h. 15 m. a.m., and it was found on October 24th 1897, on the New Zealand coast, forty miles north of Hokianga, its daily drift having been 3·6 miles per day. On October 31st 1896 at noon, that is one and three-quarter hours after No. 229, Capt. Tuke had a second current paper No. 230, thrown over, the ship being then in 36° 57′ S. and near the coast; this paper instead of following No. 229, to the New Zealand coast, made its way to Tuggerah beach, which is half way between Sydney and Newcastle, on May 27th 1898, having been five hundred and fifty-three days on the journey, if we assume that this paper made its way up the

Digitized by Google

coast, *i.e.*, the shortest way to Tuggerah beach, its drift was only half a mile per day. But there is a more probable route, and that one it no doubt followed, that is, like No. 229 it drifted away eastward on the journey, got into the current setting northwards in the eastern parts of Tasman sea (indicated by dotted line on the chart) and travelled in this current until it reached the branch of the great equatorial currents which sets past the south end of New Caledonia on to the coast of Australia, and thence went down the coast to Tuggerah beach. The daily drift necessary to accomplish such a journey is only four miles per day, nearly the same rate, 3·6 miles per day, as No. 229 made on its direct course to New Zealand.

It is of course impossible to prove which way these papers go by following them over the sea, but I may mention two other papers which seem to support the assumed track: No. 275 was thrown over by Capt. G. W. Atkinson, of the R.M.S. *Valetta*, when passing Gabo, and it was found on the Belefo Island, north of New Caledonia, having on the shortest track travelled 1,510 miles at the rate of 4·6 miles per day. No. 339 was thrown over in the latitude of Gabo Island but 7° east of it; this one found its way to one of the New Hebrides at a rate of 1·6 miles per day; probably it laid on the beach for a long time before it was found.

It is true that to reach their landing places they must have crossed the equatorial current setting westward, but they may have done so under the influence of southerly gales of which a number passed over Tasman sea during the period of the drifting of these papers. I do not press the matter, but with the well known southerly current on our coast it seems more probable that the current papers make their northing by the round about way than by facing a strong current.

Another paper bearing on this question is very interesting: No. 345 was set afloat in Lat. 46° 18′ S. and Long. 127° 50′ E., and it was found on the coast of New South Wales almost on the

Digitized by Google

boundary between that colony and Queensland. There is of course no evidence to show how it got there, for plotting on the chart it has been assumed that it followed the usual easterly drift in Lat. 46° S. to the longitude of Tasmania, and then took a northerly course, the shortest to the landing place which could be done in the time, at the rate of 5·4 miles per day. If, however, it took the alternative course, which I think the more probable, it travelled up the eastern side of Tasman sea and came on shore by the equatorial current past New Caledonia. The distance on this course being a thousand miles longer, and the daily rate of 7·5 miles per day; but during its drift in Lat. 46° S. it may, like other papers of this list, have travelled from nine to twelve miles per day, and the drift in Tasman sea would accord with those made by other papers in Tasman Sea.

It has been found impossible to plot the tracks of all the papers even with a much enlarged chart of Australia and New Zealand, because so many are found on the coast between Adelaide and Melbourne.

May I ask those who are so steadily assisting in this work to send me a tabular statement of the number of papers thrown over each month or voyage. From these returns it would be possible to get a percentage of the papers that came back to me.

Digitized by Google

Ref. No.	Date when put into the sea.	Name of Ship.	Name	Thrown Over. Lat.	Thrown Over. Long.	Where Found. Lat.	Where Found. Long.	Date when Found.	Locality.	Interval Days.	Estimated distance in miles.	Rate per day miles.	Ref. No
				° ′	° ′	° ′	° ′						
201	April 26-95	S.S. "Tsinan"	George Ramsay, Master ...	1 32 S	126 37 E.	7 20 N.	168 40 E.	Nov. 20-97	Pacific ...	940	2,970	3·2	201
202	May 5-96	,, ...	,, ,, ...	25 8 ,,	153 27 ,,	25 3 S	153 30 ,,	,, 7-96	East Coast ..	186	6	...	202
203	Nov. 10-96	,, ...	,, ,, ...	33 46 ,,	151 24 ,,	34 0 ,,	151 17 ,,	,, 13-96	,, ...	3	25	8·3	203
204	Not given	,, ...	,, ,, ...	21 58 ,,	150 47 ,,	23 50 ,,	151 20 ,,	May 24-97	,, ...	.	126	...	204
205	June 8-95	N.D.L. "Darmstadt" ...	M. Eichel, ,, ...	29 47 ,,	161 58 ,,	8 43 ,,	143 39 ,,	April 21-97	New Guinea	682	1,875	2·8	205
206	Jan. 11-97	,, ,, ...	,, ,, ...	35 31 ,,	126 19 ,,	35 16 ,,	138 30 ,,	Aug. 31-97	South Coast	232	690	3·0	206
207	Dec. 14-96	,, "Gera"	T. Stollberg, ,, ...	35 27 ,,	128 26 ,,	38 55 ,,	146 15 ,,	Nov. 5-97	,, ...	325	1,015	3·1	207
208	April 4-97	,, ,, ...	F. Meissell, ,, ...	35 35 ,,	132 49 ,,	38 5 ,,	141 0 ,,	May 20-97	,, ...	46	500	10·9	208
209	May 17-97	,, ,, ...	,, ,, ...	7 43 N.	76 53 ,,	9 0 N.	79 50 ,,	June 8-97	Indian Ocean	22	220	10·0	209
210	July 25-97	,, ,, ...	,, ,, ...	13 20 ,,	54 58 ,,	11 5 ,,	72 40 ,,	Oct. 23-97	,, ...	90	1,213	13·5	210
211	Dec. 10-97	,, "Bremen"	W. J. Overell, Esq. ...	34 40 S	150 57 ,,	36 24 S	150 5 ,,	Dec. 16-97	South Coast	6	127	21·2	211
212	July 3-95	M.M.S.S. "Armand Behic"	A. Poydenot, Commander	37 29 ,,	138 0 ,,	37 55 ,,	140 25 ,,	,, 21-96	,, ...	536	140	0·3	212
213	April 25-98	,, ,,	,, ,, ...	36 00 ,,	136 10 ,,	...	...	May 9-98	,, ...	14	149	10·6	213
214	Sept. 15-96	,, "Ville de la Ciotat"	A. Chevalier, ,, ...	35 59 ,,	129 53 ,,	34 20 ,,	119 35 ,,	Mar. 12-97	,, ...	178	590	3·3	214
215	Aug. 14-95	S.S. "Hawkes Bay" ...	M. Felgate, ,, ...	45 00 ,,	51 6 ,,	41 5 ,,	146 0 ,,	Jan. 7-97	South. Ocean	612	4,800	7·8	215
216	,, 16-96	,, ...	,, ,, ...	47 51 ,,	65 41 ,,	35 50 ,,	173 45 ,,	April 23-98	,, ...	615	5,650	9·2	216
217	,, 7-97	,, ...	J. C. Felgate, ,, ...	47 16 ,,	75 2 ,,	45 0 ,,	171 0 ,,	Aug. 14-98	,, ...	372	4,600	12·4	217
218	,, 29-95	R.M.S. "Orizaba"	A. M. Clarke, R.N.R., Comd.	23 35 ,,	104 24 ,,	0 45 ,,	42 0 ,,	,, 9-96	Indian Ocean	345	4,890	14·2	218
219	,, 18-97	,, ...	,, ,, ...	37 35 ,,	139 54 ,,	37 45 ,,	140 15 ,,	May 5-98	South Coast	260	27	0·1	219
220	Sept. 11-95	R.M.S. "Ormuz"	F. M. Tuke, Commander ...	35 37 ,,	125 35 ,,	32 8 ,,	128 0 ,,	Oct. 20-96	,, ...	404	280	0·7	220
221	Oct. 5-95	,, ...	,, ,, ...	35 5 ,,	119 3 ,,	42 10 ,,	145 15 ,,	Nov. 21-97	,, ...	778	1,500	1·9	221
222	,, 10-95	,, ...	,, ,, ...	16 2 ,,	97 59 ,,	10 31 ,,	56 40 ,,	June 8-96	Indian Ocean	242	2,840	11·7	222
223	,, 25-96	,, ...	,, ,, ...	35 34 ,,	128 23 ,,	34 50 ,,	137 10 ,,	July 28-97	South Coast	276	570	1·8	223
224	Dec. 27 95	,, ...	,, ,, ...	6 24 ,,	90 6 ,,	1 0 N.	44 0 ,,	June 15-97	Indian Ocean	536	3,225	6·0	224
225	May 7-96	,, ...	,, ,, ...	33 26 ,,	113 42 ,,	35 45 S	139 15 ,,	Nov. 6-97	South Coast	548	1,475	2·7	225
226	,, 16-96	,, ...	,, ,, ...	37 38 ,,	150 2 ,,	37 8 ,,	150 4 ,,	May 26-96	,, ...	10	35	3·5	226
227	June 13-96	,, ...	,, ,, ...	35 5 ,,	118 26 ,,	32 15 ,,	126 17 ,,	Feb 24-97	,, ...	257	500	2·0	227
228	Oct. 28-96	,, ...	,, ,, ...	38 20 ,,	141 11 ,,	37 56 ,,	140 25 ,,	Nov. 10-97	,, ...	13	50	4·0	228
229	,, 31-96	,, ...	,, ,, ...	37 17 ,,	150 10 ,,	35 0 ,,	173 12 ,,	Oct. 24-97	Tasman Sea	358	1,300	3·6	229
230	,, 31-96	,, ...	,, ,, ...	36 57 ,,	150 15 ,,	33 20 ,,	151 40 ,,	May 7 98	East Coast ..	553	272	0·5	230
231	Nov. 22-96	,, ...	,, ,, ...	38 0 ,,	140 21 ,,	37 40 ,,	140 15 ,,	Feb. 22-97	South Coast	92	40	0·4	231
232	June 21-97	,, ...	H. E. Inskip, ,, ...	35 30 ,,	134 24 ,,	37 55 ,,	140 30 ,,	July 28-97	,, ...	37	375	10·1	232
233	Oct. 15-97	,, ...	,, ,, ...	11 24 ,,	93 57 ,,	23 0 ,,	48 0 ,,	May 8-98	Indian Ocean	205	3,140	15·3	233
234	Mar. 25-98	,, ...	,, ,, ...	35 24 ,,	132 13 ,,	37 40 ,,	140 10 ,,	July 27-98	South Coast	124	490	4·0	234

Digitized by Google

Ref. No	Date when put into the sea.	Name of Ship.	Name	Thrown Over. Lat.	Thrown Over. Long.	Where Found. Lat.	Where Found. Long.	Date when Found.	Locality.	Interval Days.	Estimated distance in miles	Rate per day miles.	Ref. No
235	Feb. 26-96	R.M.S. "Austral"	J. F. Anderson, Commander	30 12 S.	110 30 E.	33 35 S	115 28 E.	June 27-97	West Coast...	486	375	0·8	235
236	,, 29-96	,, ...	,, ,, ...	35 25 ,,	123 25 ,,	37 45 ,,	140 13 ,,	May 21-97	South Coast	447	960	2·1	236
237	,, 17-97	,, ...	,, ,, ...	0 14 N.	84 48 ,,	1 0 N.	97 30 ,,	,, 18-97	Indian Ocean	90	860	9·6	237
238	July 2-97	,, ...	,, ,, ...	30 30 S.	110 40 ,,	32 0 S.	115 30 ,,	Sept. 5-97	West Coast ..	65	275	4·2	238
239	,, 2-97	,, ...	,, ,, ...	30 34 ,,	110 55 ,,	31 15 ,,	115 35 ,,	June 11-98	,, ...	344	280	0·8	239
240	,, 7-97	,, ...	,, ,, ...	35 12 ,,	137 50 ,,	35 0 ,,	138 35 ,,	July 13-97	South Coast	6	46	7·5	240
241	Nov. 9-97	,, ...	,, ,, ...	38 30 ,,	141 22 ,,	38 17 ,,	141 45 ,,	Nov. 16-97	,, ...	7	30	4·3	241
242	July 1-98	,, ...	,, ,, ...	32 17 ,,	112 33 ,,	33 10 ,,	115 40 ,,	Sept. 16-98	,, ...	77	195	2·5	242
243	June 16-96	R.M.S. "Oratava" ...	J. Linklater, ,, ...	34 6 ,,	114 30 ,,	34 40 ,,	115 50 ,,	Feb. 5-97	,, ...	234	85	0·3	243
244	,, 28-96	,, ...	,, ,, ...	34 43 ,,	115 18 ,,	33 50 ,,	121 55 ,,	Dec. 17-96	,, ...	122	380	2·2	244
245	Oct. 25-96	,, ...	,, ,, ...	38 0 ,,	140 11 ,,	37 26 ,,	139 57 ,,	Nov. 19-96	,, ...	25	40	1·6	245
246	Aug. 31-96	R.M.S. "Orient"	H. E. Inskip, ,, ...	35 38 ,,	128 58 ,,	32 15 ,,	126 27 ,,	Dec. 17-96	,, ...	108	260	2·4	246
247	Feb. 4 97	,, ...	,, ,, ...	35 29 ,,	133 5 ,,	35 5 ,,	136 30 ,,	July 31-97	,, ...	177	200	1·1	247
248	Jan. 21-97	R.M.S. "Cuzco"	H. W. Livett, ,, ...	38 15 ,,	140 56 ,,	38 13 ,,	141 15 ,,	Feb. 2-97	,, ...	12	20	1·7	248
249	Sep. 30-95	Ship "Patriarch"	Mark Breach, Master ...	40 23 ,,	138 15 ,,	36 10 ,,	173 55 ,,	Nov. 15-96	Tasman Sea	411	1,950	4·7	249
250	Oct. 9-96	,, ...	,, ,, ...	40 7 ,,	118 10 ,,	36 25 ,,	139 48 ,,	Aug. 21-97	South Coast	316	1,210	3·9	250
251	,, 11 96	,, ...	,, ,, ...	38 1 ,,	126 1 ,,	35 15 ,,	137 5 ,,	Jan. 1-98	,, ...	447	680	1·5	251
252	,, 12-96	,, ...	,, ,, ...	36 44 ,,	130 30 ,,	34 0 ,,	120 0 ,,	,, 16-98	,, ...	461	608	1·3	252
253	,, 13-96	,, ...	,, ,, ...	35 58 ,,	133 49 ,,	37 30 ,,	140 0 ,,	Oct. 9-97	,, ...	361	355	1·0	253
254	Nov. 23-96	,, ...	,, ,, ...	39 15 ,,	143 17 ,,	38 25 ,,	144 16 ,,	Dec. 20-96	,, ...	27	80	3·0	254
255	Dec. 28-97	,, ...	,, ,, ...	25 11 ,,	159 0 ,,	28 50 ,,	153 35 ,,	Feb. 23-98	East Coast ...	57	420	7·4	255
256	June 1-96	S.S. "Gulf of Mexico" ...	W. O. Warden ,, ...	43 0 ,,	95 6 ,,	38 5 ,,	140 40 ,,	June 20-97	South. Ocean	384	2,590	6·7	256
257	,, 29-96	,, ,, Genoa"	A. G. Fay, ,, ...	35 1 ,	122 16 ,,	32 17 ,,	126 20 ,,	July 17-97	South Coast	383	305	0·8	257
258	Aug. 1-96	,, ,, Aucud"	M. S. Currie, ,, ...	9 13 ,,	93 48 ,,	9 20 ,,	39 30 ,,	Mar. 9-97	Indian Ocean	220	3,700	16·9	258
259	Sept. 14-96	,, ,, Martaban"...	R. J. Hey, ,, ...	2 25 N.	82 43 ,,	8 45 N.	81 10 ,,	Feb. 14-97	,, ...	153	440	2·9	259
260	Aug. 17-96	,, ,, Lions" ...	A. Warden ,, ...	38 13 S.	135 15 ,,	37 35 S.	145 12 ,,	April 9-97	South Coast	235	270	1·1	260
261	Oct. 30-97	,, ,, ,, ...	,, ,, ...	1 51 ,,	31 24 W.	10 20 N.	61 0 W.	Jan. 16-98	West Indies	78	2,208	28·3	261
262	Mar. 1-97	,, ,, Bothnia" ...	T. G. W. Ligertwood, Mast.	39 30 ,,	126 50 E.	40 25 S.	144 55 E.	Oct 3-97	Tasmania ...	216	965	4·5	262
263	,, 2-97	,, ,, ,, ...	,, ,, ...	37 48 ,,	130 57 ,,	38 13 ,,	141 18 ,,	July 23-97	South Coast	143	570	4·0	263
264	June 9-96	R.M.S. "Arcadia"... ...	A. C. Loggin, Commander	29 39 ,,	110 30 ,,	33 50 ,,	115 0 ,,	Decr. 6-96	West Coast	180	390	2·2	264
265	July 16-96	,, ...	,, ,, ...	35 14 ,,	131 37 ,,	34 12 ,,	135 18 ,,	May 2-97	South Coast	309	260	0·9	265
266	Nov. 15-96	,, ...	,, ,, ...	37 30 ,,	139 40 ,,	35 45 ,,	139 10 ,,	July 25-97	,, ...	252	125	0·5	266
267	,, 29 96	,, ...	,, ,, ...	0 27 ,,	85 44 ,,	6 45 N.	79 50 ,,	Feb. 26-97	Indian Ocean	89	645	7·3	267
268	Aug. 3-98	,, ...	,, ,, ...	33 43 ,,	114 28 ,,	34 10 S.	114 55 ,,	Sept. 11-98	South Coast	39	38	1·0	268

Digitized by Google

OCEAN CURRENTS.

Ref. No.	Date when put into the sea.	Name of Ship.	Name.	Thrown Over. Lat.	Thrown Over. Long.	Where Found. Lat.	Where Found. Long.	Date when Found.	Locality.	Interval Days.	Estimated distance in miles.	Rate per day miles.	Ref. No.
				° ′	° ′	° ′	° ′						
269	Oct. 7-96	R.M.S. "Massilia" ...	R. Harvey, Commander ...	37 11 S.	139 32 E.	37 2 S.	139 45 E.	Oct. 21-96	South Coast	14	20	1·4	269
270	,, 10-96	,, ...	,, ,, ...	38 9 ,,	148 38 ,,	37 0 ,,	150 0 ,,	,, 27-96	East Coast ..	17	90	5·3	270
271	Nov. 1-96	,, ...	,, ,, ..	38 30 ,,	141 43 ,,	38 5 ,,	140 50 ,,	Dec. 3-96	South Coast	32	57	1·8	271
272	Oct. 9-96	R.M.S. "Valletta" ...	G. W. Atkinson, ,, ...	35 14 ,,	126 45 ,,	33 50 ..	123 0 ,,	June 6-97	,, ...	240	240	1·0	272
273	,, 23-96	,, ...	,, ,, ...	7 26 N.	77 11 ,,	12 50 N.	74 45 ,,	Nov. 27-96	Arabian Sea	35	410	11·7	273
274	Feb. 21-97	,, ...	C. Gadd, ,, ...	5 25 S.	89 20 ,,	10 40 S.	40 50 ,,	Mar. 29-98	Indian Ocean	401	3,320	8·3	274
275	Sept. 13-97	,, ...	G. W. Atkinson, ,, ...	37 53 ,,	149 30 ,,	19 40 ..	163 10 ,,	Aug. 8-98	East Coast ..	329	1,510	4·6	275
276	Oct. 25-96	R M.S. "Victoria" ...	W D.G. Worcester, R.N.R.,	16 6 N.	60 45 ,,	14 9 N.	93 18 ..	Oct. 31-97	Indian Ocean	371	2,970	8·0	276
277	Nov. 12-96	,, ...	,, ,, ...	49 35 ,,	5 13 W.	50 35 ,,	2 30 W.	Jan 12-97	Eng. Channel	61	140	2·3	277
278	Jan. 28-97	,, ...	,, ,, ...	46 10 ,,	7 29 ,,	47 25 ,,	2 35 ,,	April 10-97	Bay of Biscay	72	245	3·4	278
279	July 12-97	,, ...	,, ,, ...	29 28 ,,	32 34 E.	29 7 ,,	32 34 E.	Aug. 3-97	Red Sea ...	22	25	1·1	279
280	,, 23-97	,, ...	,, ,, ...	47 55 ,,	6 0 W.	47 40 ,,	3 30 W.	,, 20-97	Bay of Biscay	28	175	6·3	280
281	,, 24-97	,, ...	,, ,, ...	50 20 ..	2 34 ,,	50 40 ..	1 30 ..	,, 11-97	Eng. Channel	18	55	3·1	281
282	Dec. 5-96	R.M.S. "Rome" ...	A. B. Daniell, Commander	38 29 S.	148 16 E.	37 50 S.	148 0 E.	Dec. 14-96	South Coast	9	50	0·6	282
283	April 4-97	,, ...	,, ,, ...	35 12 ,,	130 28 ,,	37 5 ..	139 45 ,,	July 24-98	,, ...	476	540	1·1	283
284	May 18-97	,, ...	,, ,, ...	4 11 N.	81 46 ,,	6 31 N.	99 16 ,,	Feb. 14-98	Straits Set...	272	1,207	4·4	284
285	,, 8-97	,, ...	,, ,, ...	35 9 S.	119 20 ,,	36 15 S.	139 40 ,,	Dec. 10-97	South Coast	216	1,145	5·3	285
286	Dec. 11-96	R.M.S. "Himalaya" ...	A. W. Adamson, ,, ...	35 1 ,,	139 19 ,,	33 17 ..	138 20 ,,	Mar. 5-97	,, ...	84	260	3·1	286
287	,, 13-96	,, ...	,, ,, ...	37 12 ,,	139 30 ,,	37 10 ..	139 45 ,,	April 4-97	,, ...	112	15	0·1	287
288	Feb. 16-98	,, ...	W. L. Brown, ,, ...	12 33 N.	47 50 ,,	11 0 N.	43 30 ,,	May 1-98	Gulf of Aden	74	153	2·1	288
289	April 29-98	,, ...	,, ,, ...	35 40 S.	133 34 ,,	38 5 S	141 10 ,,	Sept. 11-98	South Coast	135	455	3·4	289
290	May 30-98	,, ...	,, ,, ...	33 7 ,,	113 26 ,,	34 45 ,,	116 5 ,,	Aug. 22-98	,, ...	84	190	2·3	290
291	Mar. 27-98	R.M.S. "India" ...	W. D. G. Worcester, R.N.R.,	38 40 ,,	145 0 ,,	38 40 ..	145 36 ,,	April 15-98	,, ..	19	33	1·7	291
292	April 1-98	,, ...	,, ,, ...	35 30 ,,	131 55 ,,	37 25 ..	139 55 ,,	Aug. 22-98	,, ..	143	467	3·3	292
293	,, 27-98	,, ...	,, ,, ...	34 50 N.	24 21 ,,	35 15 N.	24 15 ..	May 14-98	Mediterranean	17	18	1·1	293
294	May 5-98	,, ...	,, ,, ...	40 0 ,,	9 39 W.	33 45 ..	7 35 W.	June 29-98	N. Atlantic...	55	448	8·1	294
295	April 14-98	R.M.S. "Australia" ...	J. Reeves, Commander ...	35 31 S.	131 53 E.	38 4 S.	140 40 E	July 20-98	South Coast	97	520	5·4	295
296	June 22-96	R.M.S. "Miowera" ...	C. E Bird, ,, ...	3 13 N.	168 58 W.	8 10 N.	168 0 ,,	,, 1-97	North Pacific	374	1,570	4·2	296
297	Aug. 12-96	,, ...	,, ,, ...	30 4 S.	160 36 E	33 20 S	151 35 ,,	Aug. 12-97	East Coast...	365	575	1·6	297
298	Sept. 21-97	,, ...	Thos. Free, R.N.R., Comd.	27 10 ,,	175 15 ..	28 30 ,,	153 45 ..	Feb. 5-98	,, ..	137	1,360	10·0	298
299	Mar. 18-98	,, ...	,, ,,	12 13 ,,	176 30 W.	17 16 ,,	179 10 W.	Aug. 1-98	South Pacific	136	395	3·0	299
300	May 6-98	,, ...	F. A. Hemming, ,,	39 41 ,,	170 43 E.	41 55 ,,	171 23 E	June 17-98	Tasman Sea	42	160	3·8	300
301	,, 27-98	,, ...	,, ,,	40 3 ,,	171 50 ..	37 52 ,,	174 50 ..	Aug. 8-98	,, ...	73	207	2·8	301
302	July 12-97	R.M.S. "Alameda" ...	Van Oterendorp, ,,	22 56 ..	174 54 W	16 10 ..	180 0 ..	Oct. 6-97	South Pacific	86	570	6·6	302

Digitized by Google

Ref No.	Date when put into the sea.	Name of Ship.	Name.	Thrown over. Lat.	Thrown over. Long.	Where found. Lat.	Where found. Long.	Date when Found.	Locality.	Interval Days.	Estimated distance in miles.	Rate per day miles.	Ref. No.
				° ′	° ′	° ′	° ′						
303	July 13-97	R.M.S. "Alameda"	Van Oterendorp, Command	15 5 S	171 32 W.	...		Mar. 20-98	South Pacific	250	...	...	303
304	Nov. 24-97	,, ...	,, ,,	8 0 ,,	169 49 ,,	16 45 S.	179 15 E.	Aug. 21-98	,, ...	270	960	3·6	304
305	,, 26-97	,, ...	,, ,,	17 36 ,,	172 20 ,,	18 40 ,,	178 30 W	,, 14-98	,, ...	261	420	1·6	305
306	April 26-98	R.M.S. "Aorangi"	C. Hepworth, R.N.R., ,,	39 31 ,,	169 32 E.	40 15 ,,	175 10 E	July 20-98	Tasman Sea	85	305	3·6	306
307	May 13-98	,, ...	,, ,,	15 38 ,,	178 29 W.	16 10 ,,	180 0 ,,	June 29-98	South Pacific	57	40	0·7	307
308	July 8-96	Ship "Derwent"	J. R. Andrew, Master ...	42 2 ,,	107 50 E.	38 5 ,,	140 40 ,,	Oct. 9-97	South. Ocean	458	1,800	4·0	308
309	,, 11-96	,, ...	,, ,, ...	40 48 ,,	119 59 ,,	36 25 ,,	139 43 ,,	May 30-97	,, ...	323	1,110	3·4	309
310	,, 12 96	,, ...	,, ,, ...	41 9 ,,	123 30 ,,	37 9 ,,	139 45 ,,	Jan. 25-97	,, ...	197	900	4·6	310
311	,, 15-96	,, ...	,, ,, ...	39 35 ,,	136 32 ,,	40 0 ,,	143 57 ,,	Dec. 31-96	,, ...	169	400	2·4	311
312	Aug 25-97	,, ...	,, ,, ...	39 12 ,,	140 50 ,,	40 0 ,,	144 0 ,,	Oct. 4-97	,, ...	40	180	4·5	312
313	July 16-96	Brigantine "Ethel" ...	F. Limschon, ,, ...	39 12 ,,	146 20 ,,	37 43 ,,	149 30 ,,	Nov. 13-96	South Coast	120	200	1·7	313
314	Oct. 11-96	,, ...	,, ,, ...	39 10 ,,	146 35 ,,	37 45 ,,	149 0 ,,	Dec. 24-96	,, ...	74	170	2·3	314
315	Jan. 26-97	,, ...	,, ,, ...	39 23 ,,	146 7 ,,	38 50 ,,	146 12 ,,	May 18-97	,, ...	112	40	0·4	315
316	,, 25-98	,, ...	,, ,, ...	...	..	39 5 ,,	146 20 ,,	July 27-98	,, ..	183	...	...	316
317	April 5 97	,, ...	,, ,, ..	39 5 ,,	146 40 ,,	37 35 ,,	149 50 ,,	May 2-97	,, ...	27	200	7·4	317
318	Aug. 24-96	Barque "Loongana"	J. Hoggan, ,, ...	2 20 N.	175 53 ,,	6 33 ,,	147 50 ,,	Aug 28-97	South Pacific	369	2,030	5·5	318
319	July 29-97	,, ...	J. W. R McIntosh, Master	31 30 S.	156 10 ,,	32 0 ,,	152 40 ,,	Mar. 15-98	East Coast ..	229	170	0·7	319
320	Nov. 17-96	S.S. "Burrumbeet" ...	A. H. Thorpe, Master .	38 55 ,,	145 55 ,,	38 54 ,,	146 15 ,,	Dec. 21-96	South Coast	34	20	0·7	320
321	May 20-97	,, ...	W. Hipgrave, ,, ...	37 55 ,,	140 20 ,,	38 5 ,,	140 50 ,,	June 6-97	,, ...	17	30	1·8	321
322	...	,, ...	,, ,, .	35 10 ,,	150 50 ,,	35 20 ,,	150 45 ,,	Mar. 12-98	East Coast ...	...	12	...	322
323	Nov. 25-96	S.S. "Woolloomooloo" ...	H. Goodrham ,, ...	10 44 ,,	74 4 ,,	1 0 ,,	42 10 ,,	May 27-97	Indian Ocean	183	2.280	12·5	323
324	Mar. 6-97	,, ...	,, ,, ...	38 3 ,,	140 20 ,,	38 4 ,,	140 40 ,,	,, 19-97	South Coast	74	20	0·3	324
325	Oct. 11-97	,, ...	W. Penlin, ,, ...	32 50 ,,	28 22 ,,	33 35 ,,	26 55 ,,	Nov. 7-97	South Africa	27	95	3·5	325
326	Mar. 19-97	S S. "Bucephalus" ...	J. Munro, ,, ...	37 37 ,,	137 20 ,,	38 13 ,,	141 18 ,,	July 23-97	South Coast	126	225	1·8	326
327	June 13-97	,, ...	,, ,, ...	31 47 ,,	113 38 ,,	33 50 ,,	115 0 ,,	,, 25-97	West Coast	42	165	4·0	327
328	April 25-97	S.S. "Menmuir"	W. G McArthur, Master ..	38 0 ,,	149 19 ,,	37 35 ,,	149 50 ,,	Aug. 20-97	South Coast	117	40	0·4	328
329	Nov. 13-97	,, ...	,, ,, ...	29 15 ,,	153 38 ,,	28 7 ,,	153 40 ,,	Nov. 18-97	East Coast...	5	80	16·0	329
330	May 14-97	H.M.S "Dart"	W. V. S. Howard, Lieut.	29 10 ,,	153 55 ,,	23 10 ,,	150 45 ,,	Jan. 9-98	,, ...	240	483	2·0	330
331	,, 15-97	,, ...	,, Commander	28 13 ,,	154 6 ,,	23 30 ,,	151 0 ,	Feb 11-98	,, ...	272	385	1·4	331
332	Nov. 7-97	,, ...	R. W. Glennie, ,,	25 3 ,,	153 32 ,,	26 5 ,,	153 0 ,,	Dec. 27-97	,, ...	50	88	1·7	332
333	June 8-97	Ship "Samuel Plimsoll"...	John Henderson, Master...	39 47 ,,	121 28 ,,	38 35 ,,	142 53 ,,	,, 9-97	South Coast	184	1,160	6·3	333
334	Oct. 24-97	,, ...	,, ,, ...	35 7 ,,	152 29 ,,	33 25 ,,	151 38 ,,	,, 26-97	East Coast...	63	127	2·0	334
335	July 29-97	S.S. 'Thermopylæ" ...	Alex. Simpson, Commander	41 30 ,,	69 43 ,,	33 22 ,,	115 40 ,,	Sept 7-98	South. Ocean	405	2,610	6·4	335
336	Aug. 7-97	,, ...	,, ,, ...	41 35 ,,	130 6 ,,	40 0 ,,	148 0 ,,	Nov. 29-97	,, ...	114	940	8·3	336

Digitized by Google

OCEAN CURRENTS.

Ref. No.	Date when put into the sea.	Name of Ship.	Name.	Thrown over. Lat.	Thrown over. Long.	Where found. Lat.	Where found. Long.	Date when Found.	Locality.	Interval Days.	Estimated distance in miles.	Rate per day miles.	Ref. No.
337	Sept. 28-97	S.S. "Thermopylæ" ...	Alex. Simpson, Commander	33 40 S.	27 9 E.	33 30 S.	27 5 E.	May 10-98	South Africa	224	10	...	337
338	Feb. 4-98	,, ,,	,, ,,	38 39 ,,	144 2 ,,	...	...	Feb. 20-98	South Coast	16	..	...	338
339	April 14-94	S.S. "Port Hunter" ...	H. C. Spruit, Master" ...	37 49 ,,	156 26 ,,	17 47 ,,	168 23 ,,	Dec. 10-96	South Pacific	970	1,570	1·6	339
340	Sept. 12-94	Ship "Valparaiso"...	J. Menhoz, ,, ...	33 11 ,,	166 40 ,,	40 55 ,,	175 0 ,,	Jan. 2-95	Tasman Sea	112	700	6·3	340
341	Mar. 22-95	S.S. "Rotomahana" ...	W. Waller, ,, ...	34 3 ,,	160 43 ,,	25 0 ,,	153 30 ,,	Nov. 6-96	East Coast...	595	760	1·2	341
34.	June 8-95	,, "Tarawera"	W. C. Sinclair, ,, ...	33 58 ,,	155 3 ,,	32 50 ,,	151 55 ,,	May 22-98	,, ...	1079	200	0·2	342
343	Oct. 12-95	,, "Whampoa"	F. H Hards, ,, ...	27 55 ,,	153 50 ,,	30 25 ,,	153 0 ,,	June 10-98	,, ...	972	185	0·2	343
344	Nov. 25-95	,, "Wakatipu"	G. Spinks, ,, ...	45 24 ,,	160 22 ,,	41 53 ,,	174 10 ,,	Sept. 21-97	Tasman Sea	299	940	3·1	344
345	Dec. 24-95	,, "Ruahine"		46 19 ,,	127 5 ,,	29 40 ,,	153 25 ,,	April 1-97	South. Ocean	463	2,500	5·4	345
346	Jan. 31-96	,, "Waihora"	R. Neville, ,, ...	39 32 ,,	170 36 ,,	38 30 ,,	174 37 ,,	Aug. 9-97	New Zealand	556	230	0·4	346
347	Mar. 26-96	,, "Indramayo"... ...	J. W. Sanders, ,, ...	40 26 ,,	106 21 ,,	34 35 ,,	118 55 ,,	Jan. 23-97	South Coast	303	785	2·6	347
348	May 5-96	,, "Maori King"... ...	T. Priske. ,, ...	17 50 ,,	28 30 W.	13 0 ,,	38 30 W.	Sept. 1-96	S. Atlantic	119	650	5 5	348
349	Nov. 1 95	,, "Elingamite"... ..	A. H. Thorpe, ,, ...	38 0 ,,	149 0 E.	38 2 ,,	147 40 E.	Feb. 20-97	South Coast	111	75	0·7	349
3.0	Dec. 14 96	,, "Bungaree"	F. Blower, ,, ...	42 55 ,,	119 42 ,,	35 37 ,,	139 5 ,,	June 7-98	,, ...	540	1,012	1·9	350
351	,, 16-96	Barque "Bolivia"	A. St. Geo Glasson, Master	39 14 ,,	143 44 ..	38 15 ..	144 35 ..	Jan. 2-97	,, ...	17	75	4·4	351
35.	Jan 18-97	Ship "Lord Canning" ...	R. Brown, Master	47 17 N.	10 45 W.	47 20 N.	2 30 W.	Mar. 30-97	Bay of Biscay	71	390	5·5	352
353	Sept. 2-97	S.S. "Southern Cross" ...	J. F. Child, ,, ...	50 22 ,,	0 22 E.	50 40 ,,	1 35 E.	Sept. 6-97	Eng. Channel	4	85	21·3	353
354	,, 28-97	Ship "Blairgowrie" ...	J. Manson, ,, ...	20 26 ,,	80 0 W.	24 30 ,,	82 0 W.	Mar. 10-98	Gulf of Mexico	163	600	3·7	354
355	Jan. 27 98	,, "Trafalgar"	J. Gleane, ,, ...	48 17 S.	165 52 E.	43 30 S.	173 45 E.	,, 15-98	Tasman Sea	47	560	11·5	355
		The following papers have been received since the preceding list was arranged.											
356	Jan. 25-98	Brigantine "Ethel" ..	F Limschon, Master ...	39 0 S.	146 35 E.	39 40 S.	143 55 E.	Sept. 24-98	South Coast	242	155	0·6	356
357	Feb. 15-97	S S. "Gulf of Bothnia" ...	T. G. W. Lugertwood, Mast.	44 14 ,,	44 37 ,,	39 40 ,,	143 55 ,,	,, 24-98	South. Ocean	586	5,115	8·7	357
358	Sept. 11-98	,, "Indramayo"... ...	G. W. Harwood, ,,	39 33 ,,	140 32 ,,	39 42 ,,	143 55 ..	,, 24-98	South Coast	13	185	14 2	358
359	July 3-98	,, "Thermopylæ" ...	W. Philip, Junr. ,,	36 54 ,,	131 54 ..	38 0 ,,	144 40 ,,	Oct. 6-98	,, ...	95	490	5·2	359
360	Dec. 5-97	R.M.S. "Warrimoo" ...	C. W. Hay, Commander ...	1 24 ,,	171 16 W.	19 5 ,,	178 25 W.	,, 21 98	South Pacific	322	1,350	4·2	360
361	,, 27-97	Ship "Derwent"	J. R. Andrew, Master ...	42 40 ,,	156 20 E.	34 25 ,,	173 0 E.	,, 1-98	Tasman Sea	278	1,060	3 8	361
362	July 24-98	R.M.S. "Miowera" ...	F. A Hemming, Command	39 33 ,,	169 51 ..	36 30 ,,	174 10 ,,	,, 7-98	,, ...	75	320	4·3	362
363	Aug 29-98	,, "Ophir"	H. E. Inskip, ,,	33 36 ,,	113 55 ,,	34 30 ,,	115 45 ,,	,, 6-98	South Coast	38	125	3·3	363
364	Sept. 8-98	,, ,, ...	,, ,,	7 12 N.	78 34 ,,	9 0 N.	79 50 ,,	Sept. 16-98	Indian Ocean	8	155	19·4	364
365	,, 9-98	N.D.L. "Darmstadt" ...	A. von Collen, ,,	7 18 ,,	78 18 ,,	9 0 ,,	79 50 ,,	Oct. 13-98	,, ...	34	155	4·6	365
366	June 21-98	R.M.S. "India"	W. G. D. Worcester, R.N.R.,	12 36 ,,	58 26 ,,	9 15 ,,	79 10 ,,	,, 18-98	,, ...	119	1,750	14·7	366
367	July 7-98	,, ,, ...	,, Commander	35 28 S.	125 17 ,,	37 10 S.	139 50 ,,	Nov. 13-98	South Coast	129	825	6·4	367

Digitized by Google

THE GROUP DIVISIONS AND INITIATION CEREMONIES OF THE BARKUNJEE TRIBES.

By R. H. MATHEWS, L.S.

[With Plate XII.]

[*Read before the Royal Society of N. S. Wales, December 7, 1898.*]

INTRODUCTORY.

An aggregate of aboriginal tribes, with a social organisation and inaugural rites sufficiently distinct from their neighbours to justify their being ranked as a separate nation, occupy an extensive territory in the western portion of New South Wales. The most widely spread of these tribes is the Barkunjee, and I propose adopting this term for the entire nation, represented on the accompanying map as No. 1. The large and powerful communities of the Wiradjuri and Kamilaroi adjoin them on the east; their northern limits extend into Queensland, where they are met by the Kogai-Yuipera nation; on the south they cross the Murray River into Victoria. Their neighbours on the south-west were the Narrinyeri and kindred tribes of the Lower Murray; and their western boundary was situated a little way within the South Australian frontier.

It is beyond the scope of a short article like the present to attempt to define the areas occupied by the people speaking the different dialects prevalent in each of the numerous districts included in this nation, but a few of the most important and best known will be briefly referred to, and located in a general way. From Mount Murchison down the Darling River to below Menindie, the Barkunjee are the prevailing people; above them are the Unelgo and Koonoo. The Bahroonjee occupy the Lower Paroo, with the Byjerri above them; and on the Lower Darling are located the Marowera and Tungarlee tribes. From Wentworth up the Murray to beyond Swan Hill are the following small tribes:

Digitized by Google

Karingma, Tatatha, Yerri Yerri, Latyoo Latyoo, Watthi Watthi, and others. Down the Murray River, between Wentworth and the South Australian boundary, are the Yakayok, Inteck, and Takadok, who speak the Merri language. About Gnalta and White Cliffs are the Tongaranka blacks. The Mulyanappa tribe includes Lake Cobham, Milparinka, and adjacent country. At Lake Boolka and Tilcha are the Endawarra and Berluppa people respectively. The Kunatatchee and Karrengappa tribes are about Lake Bulloo, Tibooburra, and Delalah Downs.

I shall first endeavour to explain the tribal organisation, showing the groups and totems into which the community is divided, with the laws of marriage and descent established in accordance therewith. This will be followed by an outline of the inaugural rites obtaining among them, which it is thought will be found to possess a peculiar interest, owing to the fact that modified forms of ceremonies are practised in different parts of the country occupied. In the northern end of the nation, for example, the rites are dispensed in a somewhat similar manner to those of the Kamilaroi and Wiradjuri people; in the southern portion of the district the ceremonies resemble those in force among the Lower Murray tribes; whilst in a wide tract of country along the western boundary we find the rite of circumcision is incorporated with the other forms, or is to some extent in substitution of them.

Group Divisions.

The Barkunjee nation, comprising all the tribes spread over the immense tract of country delineated as No. 1 on the annexed map, are divided into two groups, distinguished by the names Muckwarra and Keelparra. If a man belong to the Muckwarra group, his wife must be a Keelparra, and *vice versa*, the sons and daughters of the marriage taking the name of the group to which their mother belongs. Arranged in tabular form, these rules of marriage and descent appear as follows:

Husband.	Wife.	Offspring.
Muckwarra	Keelparra	Keelparra
Keelparra	Muckwarra	Muckwarra

Digitized by Google

From Swan Hill to Balranald and Euston, and even further down the Murray, the Wiradjuri divisions, Murri, Kubbi, Ippai and Kumbo, are quite well known by all the local tribes. And from the Murray River southerly to Lake Tyrrell the group names Krokitch and Kamatch of the Wimmera district are equally well understood. In a similar manner, it is found that the Barkunjee divisions, Muckwarra and Keelparra, are known as far south as Lake Hindmarsh and the Avoca River. This has been brought about by the intermarriage of the members of the different adjoining tribes, who have generally been on friendly terms with each other. The group Kamatch corresponds to Muckwarra, and Krokitch to Keelparra. Kamatch is also the equivalent of the pair of sections, Murri and Kubbi, of the Wiradjuri, and Krokitch is the equivalent of Ippai and Kumbo.

Each of these two groups has a distinct selection of totems attached to it, comprising animals, plants, and different inanimate objects. The following are some of the totems of the Muckwarra division:—Common magpie, honey, galah parrot, native dog, bandicoot, teal duck, pelican, bilbee, kangaroo, porcupine, native bee, bronze-wing pigeon, eaglehawk, lizard, carpet snake, wood duck, ibis, black duck.

Among the totems of the Keelparra division may be enumerated the following:—Crow, plain turkey, emu, bony bream, swan, wallaby, padamelon, diver, opossum, shingleback, curlew, whip-snake, iguana, native companion, codfish, brown duck, mallee-hen.

According to Mr. E. M. Curr,[1] Mr. Chas. G. N. Lockhart was the first to report the names of the divisions, Muckwarra and Keelparra, in an official communication to the Government, in 1852 or 1853. Mr. Lockhart subsequently told me that about the same period he drew attention to the plucking out of the hair growing on the persons of the men.

Initiation Ceremonies.

The Kuranda.—This ceremony, the principal feature of which is plucking the hair from the bodies of the graduates, is practised

[1] The Australian Race, II., 165.

Digitized by Google

in that portion of the Barkunjee territory lying approximately south of a line drawn across the Darling River below Menindie.

The preliminaries connected with inviting the neighbouring tribes to assemble at an appointed meeting place is practically the same as that adopted by the natives in other districts, and need not therefore be further referred to at present.

On the morning of the day settled upon for the principal ceremony, all the people are astir at daylight. The boys to be operated upon are gathered out of the camp, and are painted all over with red ochre,—their heads being decorated with the down of birds. When all is ready, the guardians take charge of the novices, and a number of men armed with spears surround them in a compact circle, and all of them march away; the men making a great noise, but the boys remaining silent, with their heads bowed towards ther breasts.

The mothers of the boys, and other women present, make a pretence of resistance by throwing pieces of sticks over the heads of the men, but do not attempt to follow them. The men and graduates then proceed to a place previously agreed upon, perhaps some miles distant, where a camp is formed, and the novices placed lying down on a layer of leaves upon the ground, and are covered over with cloaks or blankets,—their guardians remaining with them. All the other men make their camp in close proximity. Between the quarters of the boys and the mens' camp, a space is cleared of all sticks and grass, with a fire lit close by it. In the evening, after the novices have partaken of their allowance of food, they are placed sitting in a row near this cleared spot, and various pantomimic displays, representing the totems of the men and boys, as well as hunting and other scenes, are performed by the men by the light of the camp fires, similar in character to the proceedings described by me in treating of the inaugural rites of other tribes.

A week or more may be spent at these camping places in the bush. During the afternoon of one or more of the days of this

Digitized by Google

period, the novitiates are carried a short distance from the camp, and placed lying down on bushes thickly strewn on the ground, and rugs spread over them. A man then sits down beside each novice, and commences pulling out the hairs of his beard, under his arms, and from the *pubes*. When one man gets tired he is replaced by another. The men of the novitiate's own tribe do not take part in the operation; this duty devolving upon the men of the different strange tribes present at the meeting; and the pluckers are the potential brothers-in-law of the novice assigned to them. Some of the head men of each tribe sit on the ground near by, directing the proceedings. The hair plucked from each novice is carefully kept by itself, and is given into the charge of one of his relatives in the same manner that the extracted tooth is disposed of in other tribes. When the plucking of the hair has been completed, the novices are raised to their feet by their guardians and other men, amid the shouts of all present. Each graduate is then painted, and invested with the usual regalia of a man of the tribe.

The novices are then cautioned against divulging the details of what they have passed through to any except the initiated. They are now taken to where the women are encamped, where they are met by their mothers and other female relatives, who light fires to the windward of them, enveloping them all in a dense smoke, caused by placing green grass, bushes or weeds on the burning wood. The graduates have to pass through the ordeal of the Kuranda at not less than two or three different meetings of the tribes for that purpose, before they can be admitted to full membership, and be permitted to take a wife.

Circumcision.—This rite is observed in more than a third of the entire Barkunjee nation, its south-eastern limits being represented by the line from A to B on the map. Mr. E. J. Eyre[1] gives an account of the ceremony of circumcision in the district of Adelaide, which took place when the novices were from twelve

[1] Journals of Expeditions of Discovery in Central Australia, (London 1845), Vol. II., pp. 333 - 335.

Digitized by Google

to fourteen years of age. As his description agrees in all essential points with the details of the ceremony told to me by old blackfellows of the Silverton, Broken Hill, and adjacent districts, I propose giving the following *résumé* from the work referred to. In those portions which I have thought it necessary to give fuller particulars, or where my informants differ from Mr. Eyre, I have added the information accordingly :—

"Early in the morning, the boys to be circumcised were seized, and a bandage fastened over the eyes of each; they were then led away from the presence of the women and children, to a distance of half-a-mile, where they were laid on the ground, and covered with cloaks and skins, so that they could not see what was passing among the adults. After some preliminaries, the men formed themselves into a circle, and kept walking round in single file—the first man having a long stick or pole held down his back. Presently all the men retired a short distance, led by the man with the pole, where a halt was made, and they formed into line, and commenced stamping and groaning, beginning at one end of the line and gradually continuing to the other. When this noise had been passed backwards and forwards along the line of men several times, they approached where the boys were lying, the bandages being now taken off the eyes of the latter. The man who held the pole fastened it in the ground, and all the others coming up took hold of it, and fell down into a heap. The boys were then thrown upon the heap of men, and the operation [circumcision] was performed by men who were supposed to be inspired, or sorcerers. Immediately after the operation the boys were taken away from the presence of all females and kept on a vegetable diet[1] until recovered from its effects. The head was covered with grease and red ochre, with a bandage passed over it, and was ornamented with tufts of feathers. The *yudna*, or pubic covering, was worn by the novitiates for some months after the operation."

[1] Animal food is also given to the novices in the district referred to in this article.

Digitized by Google

As soon as the wounds caused by the circumcision are healed, the novices are conducted to the vicinity of the women's camp, and are exhibited to their female relatives with certain formalities which I need not now occupy the space to detail.

Mr. G. F. Angas, after referring to the blacks at Moorundie and Overland Corner, states that in the Wirramaya tribe, occupying the scrub country to the north-west of that part of the Murray River, the rite of circumcision was in force. He says a bullroarer was sounded, and no women were allowed to be present. The novice was laid on his back, and then, with a sharp flint an old man cut off the foreskin, and placed it on the third finger of the boy's left hand. He was then allowed to get up, and, in company with a man selected for the purpose, went away to the hills for a time.[1] Mr. E. M. Curr says that in Yorke's Peninsula, South Australia, the boys were circumcised, and the foreskin was swallowed by the youth's father.[2]

The Tumba.—In that portion of the Barkunjee nation situated north of the tribes adopting the Kuranda ceremony, and east of those amongst whom circumcision is in force, the inaugural rite is called Tumba, which in its main features resembles the Bora of the Kamilaroi tribes. Messengers are sent out, and the mustering of the neighbouring tribes is conducted in the usual manner; and during this time the people in whose country the assemblage takes place are occupied in the preparation of the meeting place. Early in the morning which has been settled upon for taking charge of the novices, they are painted by the men from distant tribes, after which their mothers and the remainder of the women are covered over with green bushes, grass and rugs. The procedure in taking away the novices is substantially the same as that adopted on similar occasions by the Kamilaroi and Wiradjuri communities, which I have elsewhere described.[3]

[1] Savage Life in Australia and New Zealand, I, 99.

[2] Australian Race, II., 144.

[3] Journ. Anthrop. Inst., XXV., 295–339.

Digitized by Google

The boys are conducted several miles into the bush, and on arriving at the place which has been agreed upon as the camping ground, a bough yard is made for them. At night, by the light of the camp fires the men go through various pantomimic performances, imitating the animals which are the totems of those present and certain obscene gesticulations which are usually practised on these occasions. Different burlesques take place every evening, and also sometimes during the day.

The period spent by the boys in the bush is about two or three weeks, being regulated by the weather and other considerations. An important ordeal through which the novices must pass is the extraction of an upper incisor tooth. The boy to be operated upon sits on his guardian's knee held by two men. The tooth-extractor shoves the gum back with his finger nail, and the tooth is punched out with a wooden chisel. The tooth is carefully rolled up in opossum fur or bird's down, and is preserved by the boy's relatives.

One day the men strip pieces of bark resembling a cricket bat in size and shape, and sit in a row beating the ground and singing. The novices are brought and placed standing in front of these men and are told to observe them carefully. Two or more wizards or doctors now appear behind the men who are beating the ground, each with a coolamin containing human blood. They advance and the men and boys lap up the blood by means of small pieces of soft bark dipped into it, which they suck.

Another day two men stand out in an open space swinging each a bullroarer, at the end of a string eight or ten feet in length. When the graduates have paid particular attention for some minutes, the men come up and rub the instruments on the penis of each boy present, as well as on his navel, under his arms, on his chest, and other parts of the body. Armed warriors now rush up to each of the novices in a threatening attitude, and caution them against revealing what they have been taught during their sojourn in the bush.

Digitized by Google

When the programme of performances in the bush has been disposed of, all their effects are gathered up, and a start made towards the locality where it is known the women have removed their camp to. On the way thither the men who have been performing, and instructing the novices, wash their bodies in a waterhole. Men and boys then have their hair singed short, including that growing under the arms, on the *pubes*, and other parts.

A discussion is held among the relatives of each boy, including his mother's brothers, the brothers of his potential wives, and his father's people, as well as the leading men of the tribe, and a new name is assigned to each novitiate, by which he will in future be known among the initiated men. All the novices are again enjoined to observe strict secrecy respecting all these performances when speaking to the women or uninitiated, white men and women being included in the prohibition.

The neophytes are freshly painted, and dressed in the simple outfit of an Australian native before the white man made his appearance among them. All hands then proceed towards the camp of the women, near to which the novices, guardians, and the other men who have been with them in the bush, are subjected to the fire and smoke ordeal described by me in other publications.

General Remarks.—I have very briefly outlined the different ceremonies, for the purpose of keeping this article within reasonable limits. As there are portions of the rites common to every part of the Barkunjee territory, I propose dealing with a few of them under a separate head, in order to avoid repetition.

In most cases the graduates are not more than twelve or fifteen years old when first taken in charge by their sponsors, and therefore the course of instruction in the bush will extend over some years, before the youths are finally admitted to the full membership of tribesmen. During this period they are taught certain songs and dances which are never sung or enacted in the presence of women or the uninitiated. What may be termed a cabalistic

Digitized by Google

language is also inculcated; every animal and plant—in short, every object in the universe—has a mystic name which is known to the initiated only.

During the ceremonies, the tribe in whose territory the meeting is held, are required to give up one of their men to be killed and eaten by the visitors. He is slain by the men of the tribe in whose country the preceding inaugural assembly took place, and his death is in retaliation for the victim they themselves had to provide on that occasion.

Before the visitors disperse to their own districts, there is generally a real or feigned quarrel between the men of the different tribes present, after which there is promiscuous sexual intercourse and interchange of wives, by way of reconciliation.

APPENDIX.

Divisions of Some North Queensland Tribes.

In a former paper[1] I enumerated the four divisions of the Mycoolon, Myappe and Kalkadoon tribes, together with those of the Koogobathy, reported by Mr. E. Palmer in 1883. He says "The class names of the Mycoolon represent those of several adjoining and allied tribes."[2]

I am now able to report the organisation of a community of tribes in North Queensland spread over the country from the Upper Mitchell River southerly to near Gilberton, a distance of about two hundred miles by a maximum width of more than one hundred miles. Their territory commences on the Mitchell River above Gamboola Station, and extends thence to the sources of that stream, including the Hodgkinson, Walsh, and Tate Rivers; and the upper portions of the Lynd, Einasleigh, Etheridge, Copperfield and Gilbert Rivers—all flowing towards the Gulf of Carpentaria. On the eastern watershed, they include the head-waters of the Barron, Herbert and Burdekin Rivers.

[1] Journ. Roy. Soc. N.S. Wales, xxxii., 82, 83.

[2] Journ. Anthrop. Inst., London, xiii., 302.

Digitized by Google

The names of the most important of the tribes in this area are the Warkeeman, Booburam, Shanganburra, Kookoowarra, Mularitchee, Chungki, and Koochulburra. As the first mentioned is much the most numerous, and holds the largest territory, I propose giving their name to the community. The tribes of the Warkeeman community are organised into two intermarrying groups, each of which is divided into two sections, with rules of marriage and descent as exemplified in the following table :—

Group.	Husband.	Wife.	Children.
A.—	Koopungie	Cheekungie	Karpungie
	Kellungie	Karpungie	Cheekungie
B.—	Cheekungie	Koopungie	Kellungie
	Karpungie	Kellungie	Koopungie

The members of the Koopungie and Kellungie sections form a group, which may be called A; and the Cheekungie and Karpungie sections constitute Group B. There is a collocation of totems attached to each group, and the children take the name of the complementary section in the division to which their mother belongs. For the particulars of the organisation of the Warkeeman community I am indebted to the painstaking enquiries of my friend Mr. Dickson.

In Northern Queensland, between the Nicholson River and the north-west corner of that colony, extending southerly a considerable distance from the Gulf of Carpentaria, are some tribes possessing a different organization to any of those hitherto reported in other parts of Queensland. They are divided into eight sections —four of which form a group, which I have called A, and the other four Group B. The names of these sections, with the rules of intermarriage, and the sections to which the offspring belong, are exemplified in the subjoined table :—

	Husband.	Wife.	Sons.	Daughters.
Group A.	Bolangee	Nungallermer	Bullerringee	Nulyarramer
	Kommerangee	Nulyarramer	Burralangee	Nurralammer
	Narrabalangee	Nurralammer	Bongaringee	Nongarimmer
	Yakamurry	Nongarimmer	Kunuller	Nungallermer

Digitized by Google

Group B.	Kunuller	Nolangmar	Yakamurry	Jummeyunyee
	Bongaringee	Jummeyunyee	Narrabalangee	Neonammer
	Burralangee	Neonammer	Kommerangee	Nemurramer
	Bullerringee	Nemurramer	Bolangee	Nolangmar

It is seen by this table that the sons of one group marry the daughters of the other in a certain fixed rotation; and that a brother's son's children intermarry with a sister's son's children. Groups A and B, and the sections of which they are composed, are respectively equivalent to the A and B groups tabulated by me on page 75 of this volume.[1] The particulars from which the above table is prepared were supplied to me by Mr. Shadforth.

My son, who has travelled over the greater part of North Queensland, informs me that among the blacks on the Johnstone River, which flows into the ocean between Cairns and Cardwell, there are two divisions known as Koorabunna and Kooragula.[2] The former is equivalent to Wootaroo, and the latter to Yungaroo of the Kogai-Yuipera nation.

The following are some of the totems of the Koorabunna people: Fish-hawk, scrub turkey, lizard, oyster, bloodwood, mangrove, tea-tree, sun, daylight, white cockatoo, salt-water perch, large turtle, stingaree, canoe, boomerang, fish-hooks and lines, white paint, fresh water.

Among the totems of the Kooragula division are the under-mentioned animals, plants, and personal effects:—Native companion, saltwater, alligator, wattle tree, ironbark, tomahawk, dilly bag, spear, wallaby, black snake, crow, jackass, shark, red paint, spear, night.

Between the people just referred to and Halifax Bay, and on Hinchinbrook and the Palm Isles, are some tribes bearing the four section names reported by Mr. E. M. Curr in 1886, namely,

[1] Journ. Roy. Soc. N.S. Wales, xxxii., 75, 76.

[2] My informant states that in some parts of the district he observed a third division, named Koorameenya, but he had not time to complete his investigations.

Digitized by Google

Koorkeela, Koogooroo, Woongo and Widjeroo, with the rules of marriage and descent given by him in his valuable work.[1]

From Broad Sound to Port Curtis, and reaching inland beyond the junction of the Fitzroy and Dawson Rivers are several small tribes, the best known of which is the Kooinmerburra. Their primary divisions are Wootaroo and Yungaroo—the first being subdivided into Moonal and Karilburra, and the latter into Kooialla and Koorpal. For these particulars I am personally indebted to Mr. W. H. Flowers, of Medway Station, Bogantungan.

In an article contributed in 1894 to the Queensland Branch of the Royal Geographical Society of Australasia,[2] I inadvertently omitted to mention that Mr. E. M. Curr was the first to report the divisions of the Wokelburra tribe on the Belyando River. I have, however, since amply recognised his valuable researches over a large extent of country in that part of Queensland.[3]

If the tribal organisations given in this Appendix be read in connection with an article contributed by me to the American Philosophical Society,[4] it will be found that I have described the divisional systems of the principal native communities of Queensland, extending from the boundary of New South Wales to the Gulf of Carpentaria, and thence to the Kennedy River, flowing into Princess Charlotte Bay, on the eastern coast. This immense area comprises the whole of the colony of Queensland, with the exception of the northern portion of Cape York Peninsula.

Explanation of Plate.

No. 1 on the map represents the Barkunjee nation, which is situated chiefly in New South Wales, but extends a little way within the frontiers of each of the three adjoining colonies,—Victoria, South Australia, and Queensland. In this community I have included all those tribes who possess the group divisions known as Muckwarra and Keelparra. It has been shown in earlier

[1] Australian Race, II., 418 and 425. Mr. Curr gives some variations in the names of the four sections mentioned, among adjacent tribes.
[2] Proc. Roy. Geog. Soc. Aust. (Q.) X., 30.
[3] Journ. Roy. Soc., N. S. Wales, XXXII., 80.
[4] "Divisions of Queensland Aborigines."—Proc. Amer. Philos. Soc., (Philadelphia, U.S.A.) Vol. XXXVII., No. 158, with map of Queensland.

Digitized by Google

pages of this article that the communities composing this nation practised three types of initiation. This was due to their incorporating portions of the ritual of their neighbours into their own, which is particularly noticeable among the small tribes on the Murray and Lower Darling, who have adopted the hair plucking ceremony from the adjoining Narrinyeri nation. Among the tribes about Swan Hill, Moulamein, Balranald, and the junction of the Murray and Murrumbidgee Rivers, during an assemblage for initiatory purposes, there was always a large proportion of the Wiradjuri people present, in consequence of which there was an overlapping or intermingling of the customs of both communities in that district.

Nos. 2 and 3 are the Kamilaroi and Wiradjuri nations respectively, who adjoin the eastern boundary of the Barkunjee throughout its whole length.

No. 4 shows the north-west corner of the Bangarang community who occupied Central Victoria from the Murray River to Port Phillip. The Wiradjuri nation, No. 3, adjoins them on the north, along the valley of the Murray, but evidences of the Wiradjuri Burbung are observable for as much as fifty miles within the Victorian frontier.

No. 5 represents the northern extremity of what I have designated the Booandik nation, after the tribe of that name at Mount Gambier, whose organisation is identical. The group divisions throughout this community are known as Krokitch and Kamatch, the feminine forms of the names being Krokitchgor and Kamatchgor. If a man belong to the Krokitch group, his wife must be taken from among the Kamatch people, and *vice versa*, the children taking invariably the appellation of the group to which their mother belongs.

The natives of the Murray River, from Euston to above Swan Hill used to meet and mingle with those inhabiting the Avoca, Avon, and Wimmera Rivers.[1] I have found that in consequence of this intercourse of the tribes, the ceremonies of initiation com-

[1] Aborigines of Victoria, I., 38.

Digitized by Google

mon on the Murray extend as far south as Lake Hindmarsh. Traces of the Wiradjuri Burbung are also noticeable to the west of the Lodden.

No. 6. I have denominated the aggregate of tribes who occupied the tract of country here represented, the Narrinyeri nation, following the name of the tribe who were formerly located about Lake Alexandrina, and the adjacent district. A prominent feature of their inaugural ceremonies is the plucking out of the hair from different portions of the body of the graduate, "the secret parts suffering the most."[1] Their north-western boundary from B to C is also the eastern limit of the custom of circumcision. The northern continuation of this line from B to A, passing through the corner of New South Wales, is also delineated upon the map. The position of this line from A northerly to the Gulf of Carpentaria, being within Queensland territory all the way, is given by me elsewhere.

The divisional systems and inaugural rites of the natives inhabiting the country represented by Nos. 4, 5 and 6 on the map, are dealt with in a comprehensive article on "The Victorian Aborigines," contributed by me to the Anthropological Society of Washington, U.S.A., last year.

No. 7 is the country of the tribes having the group names Matturri and Karrara, who reach as far north as Cooper's Creek, adjoining the Barkunjee tribes all the way.

No. 8 represents the Kogai-Yuipera nation, who adjoin the Barkunjee and Kamilaroi on the north. They are segregated into two primary intermarrying groups, Yoonga and Ootheroo; the former is subdivided into two sections, called Bunburri and Koorgilla, and the latter into two, called Woongo and Koobaroo. To the east of these people is the Dippil nation, extending from the sea coast to include the valley of the Dawson and Upper Condamine Rivers. They are divided into Deeajee and Karpeun, with the sub-divisions Derwine and Bunda, and Banjoora and Barrang respectively.

[1] Folklore, Manners, etc. of S. A. Aborigines, (Adelaide 1879), p. 27.

Digitized by Google

THE BLUE PIGMENT IN CORAL (*HELIOPORA CŒRULEA*) AND OTHER ANIMAL ORGANISMS.

By A. LIVERSIDGE, M.A., LL.D., F.R.S.,
Professor of Chemistry in the University of Sydney.

[*Read before the Royal Society of N. S. Wales, December 7, 1898.*]

THE following notes contain the results of some preliminary experiments upon the blue pigment present in the blue coral known as *Heliopora cœrulea*. Some fragments of the coral were supplied to me by Professor David, which had been collected by him at Funafuti, when conducting the Coral Reef Exploration Expedition in 1897. He states that the *Heliopora cœrulea* is there very abundant in places.

The occurrence of the blue colouring matter in this coral is drawn attention to by the late H. N. Moseley, F.R.S., in the Challenger Reports,[1] who points out that it can be partly separated by dissolving away the calcareous matter by means of hydrochloric acid, and dissolving the pigment in alcohol—he however did not obtain it in a pure form nor did he ascertain its chemical composition; but he gives a full account, illustrated by drawings, of the way in which it occurs in the coral. He states:—"The blue tint is seen in sections of the corallum of *Heliopora cœrulea* to be diffused within the hard tissue. The colour is faint or almost absent in the freshly-growing tips of the corallum, and pale in the most recently formed superficial structures generally; it is darkest in the layer lying immediately beneath these, that is to say, in the most recently matured tissue.

"In transverse sections it is seen to be darkest at the surfaces of the walls of the tubes and calicles. In vertical section of the

[1] Zoology, Vol. II., p. 109; see also H. N. Moseley, "On the Colouring Matters of Various Animals, and Especially of Deep Sea Forms Dredged by H.M.S. *Challenger*."—Quart. Journ. of Micro. Soc., New Ser., Jan. 1877, Vol. XII., p. 2.

Digitized by Google

corallum the continuation of the dark blue line marking the margin of the wall of each tube enables the line of the tube to be traced past the superadded tabula, and marks the boundary between the two structures. Very exceptionally, intensely blue streaks are developed more internally on either side of the central canal. The tabulæ are almost colourless."

Separation of the Pigment.

On shaking the finely powdered coral with water, the blue pigment does not float, as might have been anticipated, but rather tends to collect at the bottom of the vessel; not sufficiently however to be used as a means of separating and collecting it.

As stated by Moseley the readiest way to separate the pigment from the mineral matter of the coral is to dissolve the coral in hydrochloric acid, when the blue colouring matter mixed with animal matter is left in suspension, it can then be filtered off from the calcium chloride solution, which passes through the filter in a colourless condition.

Some of the pieces of coral were old and waterworn, "dead" coral :—a specimen of this dissolved in pure hydrochloric acid left a small quantity of insoluble residue amounting to about ·2%; under the microscope this was seen to consist of rock debris, probably pumice, and a few crystals and groups of crystals of magnetite.

One specimen of such "dead" coral yielded ·267% of the crude pigment after drying in a water oven. A specimen of the unrolled or "live" coral yielded 1·123% of the dried pigment, the greater yield from the "live" coral appears to be due to the larger amount of animal matter mixed with the pigment.

The crude pigment as set free from the coral by hydrochloric acid is black in colour, and on drying splits up into small pieces with very lustrous conchoidal surfaces, and it is exceedingly tender and so brittle that on crushing much of it flies out of the mortar.

Digitized by Google

On ignition the pigment gives off nitrogenous odours, intumesces greatly and the charred residue acquires deep blue, green, and other iridescent colours, similar to those sometimes seen on coke and specimens of hæmatite: this sheen did not readily burn off. No crystalline structure could be detected in the intumesced char—(indigo, if present, would probably have been sublimed and deposited in the cavities, it was accordingly specially searched for) finally a bulky ferruginous-looking ash was left. The ash was found to contain much phosphoric acid, together with iron, lime, and magnesia.

Moseley states that the blue colouring matter left by hydrochloric acid can be *at once* dissolved off the filter by alcohol; this may be the case with the perfectly fresh coral, but I found that the colour from the old dead coral is only slightly soluble, and even absolute alcohol only dissolves it in part. On evaporation, this extract leaves a dark olive-green residue; (indigo leaves a blue residue) which intumesces on ignition and leaves a little ash.

To ascertain its solubility ·648 gramme of the blue residue left by hydrochloric acid was extracted for some hours with 75 c.c. of absolute alcohol in a percolator over a water bath; the dark green alcoholic extract when evaporated to dryness in a platinum dish over a water-bath, left a dull dark green coloured and blistered residue weighing ·115 gramme, equal to 17·8% on the crude pigment, and to ·18% on the original coral.

On warming, it melts and becomes very fluid, but solidifies on cooling; at higher temperatures it gives off much fume and a disagreeable nitrogenous odour like burnt fish and finally inflames; the carbon burns off very quickly and some ash is left, viz., the above ·115 gramme of pigment left ·0061 gramme or 5·33%. This ash dissolved in hydrochloric acid to a pale yellow colour and was found to contain iron, phosphoric oxide, lime and magnesia; the quantity (·0061 gramme) was insufficient for a complete examination.

Next, ·648 gramme of the blue colouring matter left by hydrochloric acid was placed in a percolator with 60 c.c. glacial acetic

Digitized by Google

acid and digested on a water bath for five or six hours. During extraction in the percolator the original blue colour gradually changed to a dark green.

The extract was evaporated to dryness in a platinum dish over a water bath, the dried extract weighed ·171 gramme or 26·45% on the above, or ·268% on the original coral, hence the acetic acid extracts a larger proportion of matter than alcohol, but the amount of pigment dissolved may not be proportionately greater; the residue was dark green in colour, with a resinous appearance, closely adherent to the dish, without blisters, and somewhat deliquescent.

On heating, the residue melted and assumed purple, blue and other iridescent tints; it also gave off a disagreeable nitrogenous odour like burnt fish, similar to that from the crude pigment set free by hydrochloric acid and by the alcoholic extract; dense white inflammable fumes were also emitted.

The fixed residue or ash was of a brownish colour and weighed ·0123 gramme equal to 1·90%. It was found to consist principally of iron, phosphoric oxide, lime and magnesia. Hence the acetic acid extracts more organic matter and less ash or mineral matter.

No traces of crystal form could be detected even under the microscope in any of the residues left by the acetic acid solutions.

On evaporating the glacial acetic acid solution of the pigment to dryness over a water bath and taking up with hot glacial acetic acid a second time, the solution was of a light brown colour instead of blue. The ash from this brown extract also contained iron and phosphoric acid.

When solutions of the coral blue and of indigo in acetic acid are compared side by side the former is seen to be brighter and to have a green shade as compared with the indigo blue. The colour is between that of indigo and copper sulphate solution.

When a luminous flame is viewed through it the flame appears of a bluish-green, but when viewed through sulphindigotic acid or indigo in acetic acid, the flame is more or less reddish-purple.

Digitized by Google

The spectrum of the coral blue in glacial acetic, formic and lactic acids and alcohol is mainly blue and green, a little of the extreme red is visible and some of the yellow, but the bands are by no means well defined.

Solutions in glacial acetic acid when diluted gradually fade and a voluminous whitish flocculent precipitate of organic matter is formed, which on ignition burns with a nitrogenous odour.

The undiluted solutions in glacial acetic, in strong formic and propionic acids faded very slowly, and did not become turbid even after standing some six months. The strong solutions of the pigment when exposed to the light do not fade so quickly as those of sulphindigotic acid and of indigo in glacial acetic acid. To test this, solutions of equal depth of colour were made and left exposed to diffused daylight; the indigo solutions faded and lost the blue tint in a day or two, and after a week or two became practically colourless, while the coral blue solution had faded but slightly. A faded solution of indigo in glacial acetic acid is quite red (salmon colour) by gas-light.

The alcoholic solution fades more quickly than the acetic and formic acid solutions, and especially when diluted; a flocculent precipitate is gradually formed and the solution turns brown; finally after two or three weeks it becomes colourless.

The best solvents for the pigment were found to be formic acid, hot glacial acetic and lactic acids and absolute alcohol.

The acetic acid solution does not dye wool, silk or cotton, neither is it fixed by alum or ammonia.

It yields a very pale bluish-lake with alum and ammonia, but the colour fades in a few days. It also yields precipitates with baryta and lime waters, also with lead acetate; these precipitates require further examination.

Action of Reagents.

1. *Alcohols and their Derivatives.*—The crude pigment set free by hydrochloric acid is insoluble in methyl alcohol, also in ordinary alcohol, although soluble in absolute alcohol; it is insoluble in cold

Digitized by Google

amyl alcohol, but on boiling it yields a dull greenish coloured solution. It is also insoluble in amyl acetate. It is insoluble in ether, ethyl acetate, and chloroform; also in acetic anhydride although glacial acetic acid is one of its best solvents.

When boiled with dichloracetic acid it yields a pale green solution, with monobromacetic acid it yields a pale grass-green solution changing to a greenish-brown on boiling.

It is insoluble in oil of winter-green (methyl salicylate).

It is but slightly soluble in aldehyde, in paraldehyde and in acetone. It is insoluble in glycol; with glycerol it gives a pale greenish solution which quickly fades; it also imparts a pale green colour to hot dichlorhydrin.

2. *Hydrocarbons.*—It is not dissolved by kerosene, naphtha, nor by the pure paraffins, neither is it soluble in such olefines as caprylene and octylene, the latter however acquires a slight green tint when heated with the pigment.

With eucalyptus oil it yields a pale green solution and leaves a greyish gelatinous-looking residue of proteid matter, many times the volume of the original pigment, with black specks of the colouring matter embedded in it.

It does not yield a coloured solution with turpentine, either hot or cold, but after standing in it for some weeks the turpentine lost its original pale straw coloured tint and became viscid, the pigment also lost its colour and left a grey residue or skeleton.

3. *Acids.*—With nitric acid the pigment gives a yellow or orange coloured solution fading to yellow, probably due to the formation of picric acid. The colour is not restored by alkalis.

It has already been stated that the pigment is insoluble in hydrochloric acid.

It is insoluble in dilute sulphuric acid, 1 to 4 aq., but with concentrated sulphuric acid it gives a greenish coloured solution in the cold; on boiling the colour darkens, and on filtering through glass wool an almost black liquid is obtained; on dilution a dusky

Digitized by Google

blue filtrate passes through, but on standing, a black precipitate forms and the solution becomes colourless; this black precipitate gives a blue solution with acetic acid, so that the pigment is sufficiently stable to resist the action of hot sulphuric acid.

Organic Acids.—Formic acid dissolves it readily both hot and cold to a beautiful blue colour similar to that yielded to acetic acid; on evaporating to dryness over a water bath it leaves a greenish coloured residue, and this on ignition chars in much the same way as the acetic residue and leaves a ferruginous-looking ash.

The residue insoluble in acetic acid and the other above-mentioned solvents after repeated treatment, until the solvent no longer became coloured, is practically black. On heating this residue on platinum it burns slowly without flame, emits a nitrogenous odour, and leaves a considerable amount of ash, which is of a ferruginous colour, and appears to have much the same composition as that from the crude pigment itself.

Propionic Acid.—Slightly soluble in the cold; when boiled it yields a bright blue solution equal to that in glacial acetic acid, and as permanent.

Propionitril.—Insoluble.

Butyric Acid.—Insoluble in the cold but yields a pale greenish solution when boiled. *Isobutyric Acid* takes up a little of the blue on warming.

Heptoic Caprylic and Nonylic Acids.—Insoluble.

Lactic Acid (Ethylidene lactic acid).—Slightly soluble in the cold, but when warmed the solution is a full bright blue, as good as the acetic acid solution. The black residue insoluble in lactic acid imparts no colour to acetic acid. On concentrating the lactic acid solution over the water bath, the colour gradually fades and acquires a light brownish tint.

Glycollic Acid.—Gives light green solution, a little darker on warming.

Oleic Acid.—Insoluble, on boiling the acid becomes brown.

Digitized by Google

Tartaric Acid.—A faint blue colour on boiling.

Oxalic Acid.—Insoluble.

Citric Acid.—Yields a pale blue solution on boiling.

4. *Alkalis.*—In cold dilute ammonia it gives a pale blue solution which gradually fades in the course of a few weeks. It is much more soluble in strong ammonia, also in hot ammonia. On evaporating to dryness the residue is of a brownish colour.

It imparts a greenish colour to potash, both dilute and strong solutions, but when boiled with potash the solution turns brown. Moseley states that the colour is restored by acids, but I did not find this to be the case; a very faint dusky purple only was obtained. When boiled with ammonium, sodium and potassium carbonates, it in each case yields a dingy slate coloured solution with a slight purple tinge.

Aromatic derivatives.—It is insoluble in benzene. Nitrobenzene is coloured green by it, but on heating this darkens and becomes brown. It also imparts a greenish tint to colourless phenol in the cold; on heating it yields a dark solution—the pigment does not, like indigo, appear to be redeposited on cooling. On evaporating down to dryness over a water bath and driving off the phenol, the pigment was left as a sap-green resinous-looking film, which under the microscope was seen to be made up of drop-like forms without any trace of crystallisation.

It appears to be insoluble in xylenol and also in aniline.

It is partly soluble in cresol (meta) to a dark green solution, and in cold creosote to a pale green, in hot creosote it yields a dark green solution similar to cresol.

The phenol, cresol, xylenol, aniline and other similar solutions were filtered through glass wool and evaporated but none of them deposited the pigment in a crystalline form.

Salts.—It was found that the pigment is insoluble in sodium chloride and nitrate, both in the cold and when boiled. The acetate of sodium gave a slight shade of green, and the phosphate

Digitized by Google

a hardly perceptible dusky purple tint. It is also insoluble in magnesium sulphate and stannous chloride. On boiling with stannic chloride a bright blue solution is apparently obtained, but on filtering, most of the colour is left on the filter and a very pale blue solution passes through.

Other Reagents.—No colour was imparted to olive oil, and the particles of pigment remained in it unbleached, although exposed to the light for some months, but the olive oil became quite colourless and viscid. It was found to be insoluble also in carbon disulphide, carbon tetrachloride, chloropicrin, thiophen, oil of cloves, cane sugar solution, etc.

In all cases, although not always specifically stated, the reagent was used hot as well as cold, and in most instances the cold reagent was allowed to stand upon the pigment, with daily shakings, for several weeks.

It is bleached by chlorine water (the colour is not restored by alkalis) and a greyish coloured residue is left (several other reagents left a similar residue); this residue or skeleton burns with a nitrogenous odour and leaves a considerable amount of ash —it apparently consists largely of the membrane of the pigment cells and perhaps cornein ($C_{30}H_{44}N_9O_{13}$). The ash is ferruginous in appearance and contains iron, phosphoric oxide, lime etc.

A mixture of glucose, ferrous sulphate and lime does not appear to reduce it as is the case with indigo.

The colour is discharged by nascent hydrogen (from zinc and hydrochloric acid) also by hydroxyl, and sulphurous acid, and it is not restored by neutralising with an alkali.

After the above experiments were completed, the crude pigment was obtained by means of hydrochloric acid from the growing points of "live" coral, *i.e.*, coral which had been gathered while growing.

The tips or growing points were of a dull slaty-blue colour both externally and internally, and I expected them to yield a fuller blue than the "dead" coral, but the pigment obtained was of a

Digitized by Google

pale chlorophyll green tint, and its solutions in alcohol, glacial acetic and lactic acids were also of a pale green colour; it was practically insoluble in formic acid.

Under the microscope it was seen to be largely made up of membranous matter and cells containing granules of the green pigment. On exposure to light this green pigment gradually darkened somewhat.

Other Animal Blue Pigments.

The late Prof. H. N. Moseley, gives an account of certain blue and other animal pigments in his paper on the colouring matter of various animals.[1]

Purple Pentacrinin.—He states that many species of pentacrinins readily yield to acidified alcohol colouring matter with well defined spectra. The two principal bands correspond very nearly to those of turacin.

When rendered alkaline by ammonia the solution becomes bluish-green. When the acid solution of pentacrinin is carefully concentrated it yields a dark violet amorphous precipitate, which is only slightly soluble in alcohol; it is not soluble in hydrochloric acid alone.

The fresh colouring matter is soluble in fresh water, but remains partly suspended, forming a slightly opaque dark purple solution, on acidifying it entirely dissolves to a beautiful pink; when this is rendered alkaline a green flocculent precipitate is thrown down.

Antedonin.—Antedonins are usually rose, orange, yellow or brown colour to purple. A dark purple one was dredged off Cape York, Australia. The pigment was insoluble in glycerin, largely soluble in fresh water, and very soluble in weak spirit, and gave an intense fuchsine coloured solution, becoming pinker on dilution with alcohol.

When the alcoholic solution is rendered alkaline by ammonia it changes to a deep violet, and a flocculent purple precipitate is

[1] Quarterly Journ. Micro. Science, xvii, 1877.

Digitized by Google

formed, yielding a violet amorphous powder when dried, insoluble in alcohol and in oil of cloves.

A similar or the same colouring matter was yielded by a holothurian, from the South Indian Ocean; Moseley regarded it as identical with antedonin.

Land planarians.—Two large species of *Rhynchodemus* were found at Parramatta, N.S.W., one red and the other prussian blue. The blue is insoluble in alcohol, and becomes red on adding hydrochloric acid and is soluble in acidified alcohol.

Mollusca—Aplysiopurpurin.—A purple fluid is emitted by an *Aplysia* abundant on the shore of St. Vincent, Cape Verde; the purple fluid is soluble in alcohol. Said to contain aniline.[1]

The purple colouring matter used by the ancients for dyeing linen and woollen, known as punicin, yielded by *Purpura capillus* and other mollusca, is a colourless secretion which becomes purple on exposure to light. It crystallises readily from its solution in aniline and is insoluble in alcohol and ether. Like indigo it can also be crystallised by sublimation.

Doris.—A *Doris* had the surface of the foot coloured a dark purple, the pigment is soluble in alcohol acidified with hydrochloric acid—the spectrum resembles that from *Aplysia*.

Ianthinin.—The pigment of the purple fluid emitted by *Ianthina* was found to be soluble in spirit to a pale pinkish-blue tint, and shows a brilliant red fluorescence like æsculin which is also blue by transmitted light. On adding a drop of hydrochloric acid the colour changes to a clear pale blue—the spectrum is well marked. The pigment is also soluble in glycerin and yields a deep violet coloured solution. The solution in ether resembles that in alcohol; but leaves a residue which dissolves in absolute alcohol to a blue solution. The ianthinin solutions all faded in a week or two.

Blue Stentorin.—Prof. E. Ray Lankester found that the blue pigment of *Stentor cæruleus* yields two well marked absorption

[1] See Gmelin, Vol. XVIII., p. 422.

Digitized by Google

bands in the spectrum, one in the red and the other in the green; also that it is unaffected by dilute acetic, hydrochloric and sulphuric acids, while dilute potash intensifies it.

He also speaks in the same paper[1] of the blue pigment of *Velella*, as being probably identical with that of other oceanic hydrozoa; no detached bands are exhibited, but the red and violet ends of the spectrum are cut off.

Fish.—Geo. Francis, (Adelaide) describes a bluish-green colouring matter from certain species of *Odax* common in St. Vincent's Gulf, S.A., giving a spectrum somewhat resembling that of chlorophyll.[2] The pigment is soluble in water, rather bluer than chlorophyll; sulphuric acid precipitates it with albumen, but does not destroy the colour; it is bleached by light. The pigment is nitrogenous, and is destroyed by heat, chlorine, acetic acid, alkalis, ammonia, and alcohol.

Turacin.[3]—A blue pigment from the feathers of the turacoa or plantain-eater, it is soluble in water and contains copper.

Indigo—Although essentially a vegetable production, it was specially tested for, since an indigo-forming substance occurs in both normal and morbid urine.[4] But no certain indications of the presence of indigo were obtained from the coral pigment.

Pyocyanin.—Formed occasionally in pus. It forms blue acicular crystals arranged in crosses or rosettes. Melts on heating and does not sublime. Soluble in water; reddened by acids, but the colour is restored by alkalis. Neither the alcoholic nor the aqueous solution is precipitated by alum or lead acetate.[5]

Hæmocyanin.—This is present in the blood of certain cephalopods, gasteropods, crustacea and arachnida, and plays the same

[1] Quart. Journ. Micro. Science, 1873, p. 142, and Journ. of Anatomy and Physiology, Vol. IV.

[2] For figure and description see "Nature," Dec. 30, 1875, p. 167.

[3] A. H. Church—Phil. Trans. Roy. Soc., 1869, p. 627.

[4] For authorities see Gmelin, Vol. XVIII., p. 407.

[5] Gmelin, XVIII., p. 415.

Digitized by Google

part as h
carrier of
and becom
and again
place of t
precipitate

Emu Eg
beautiful s
lactic acids
the coral.

Crustace
red on boil

It is unfc
composition
the non-cr
attention t
allied to th

From the
this coral
animal blue
can be defin
ment and m

I am exp
cærulea wh
extraneous
its accompa
sulphur.

Digitized by Google

Digitized by Google

part
carr
and
and
plac
prec

Æ
beau
lacti
the

C
red

It
com
the
atte
allie

F
this
anim
can
men

I
cœru
extr
its
sulp

Digitized by Google

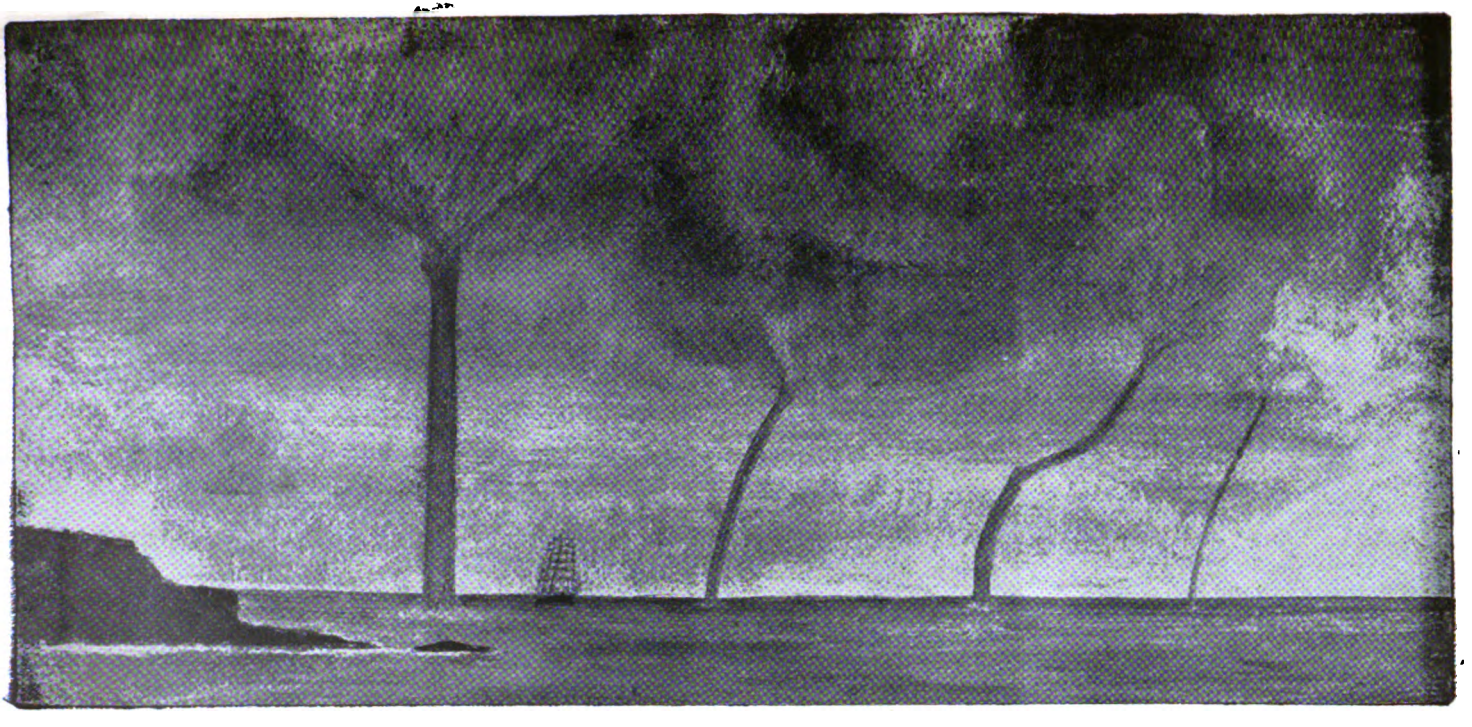
Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

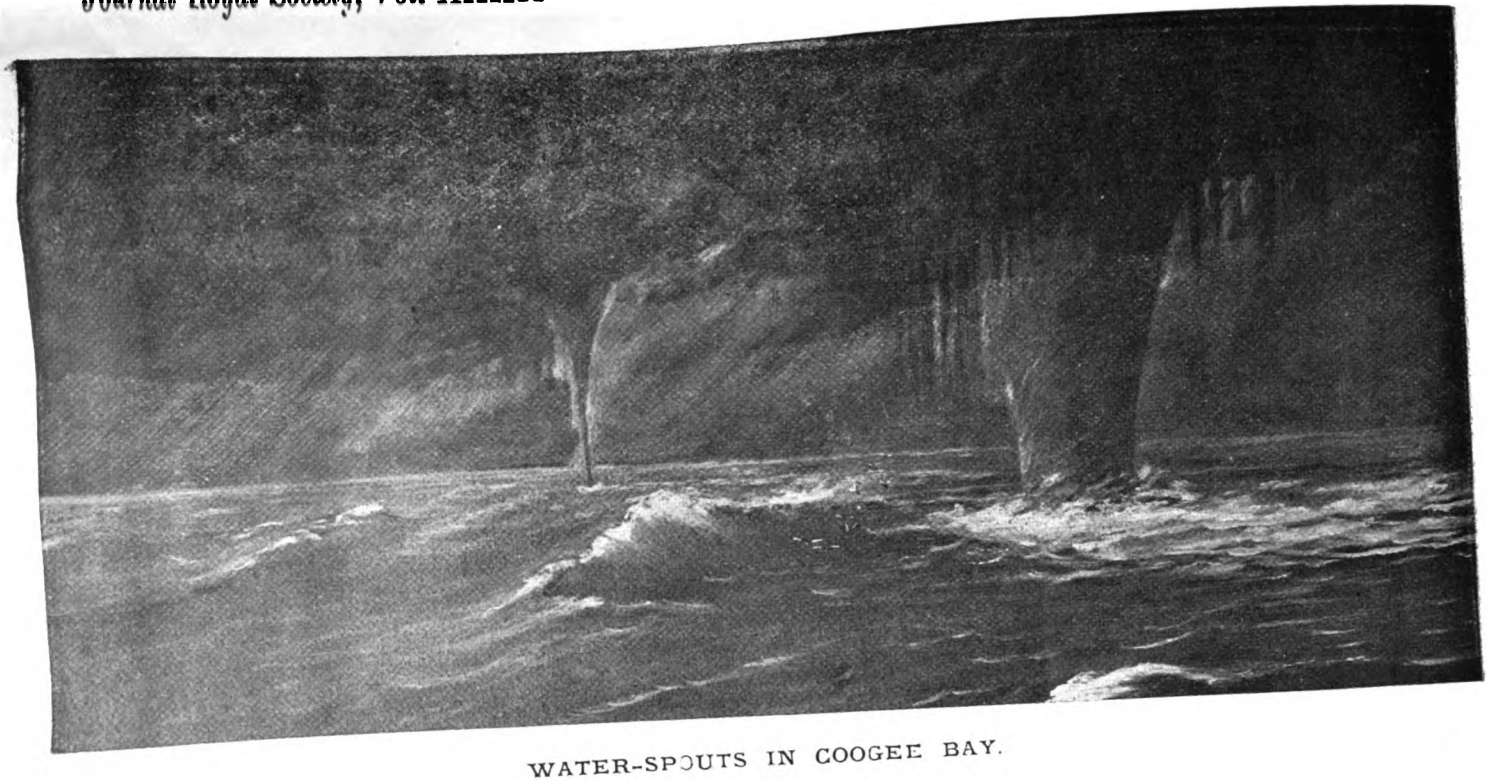
Digitized by Google



FOUR OF THE WATER-SPOUTS SEEN AT EDEN.

Digitized by Google

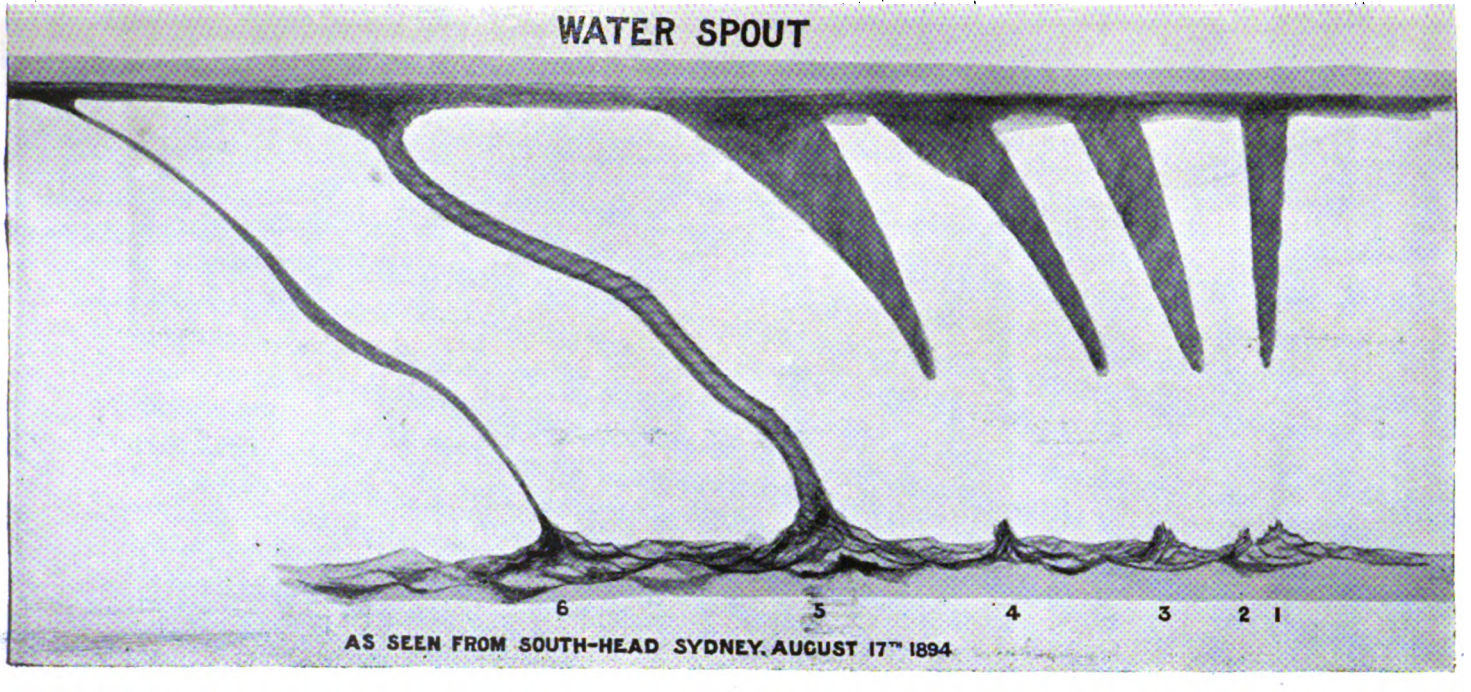
Digitized by Google



WATER-SPOUTS IN COOGEE BAY.

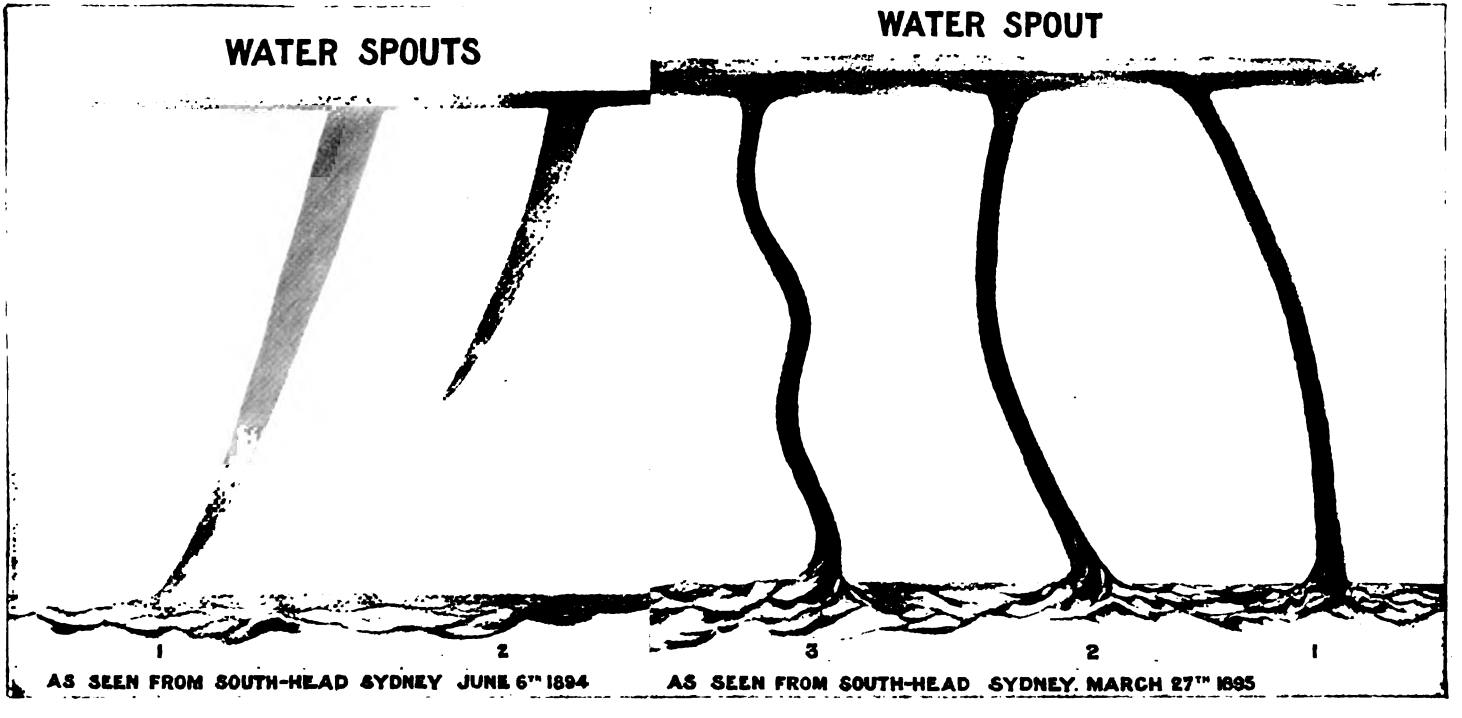
Digitized by Google

Digitized by Google



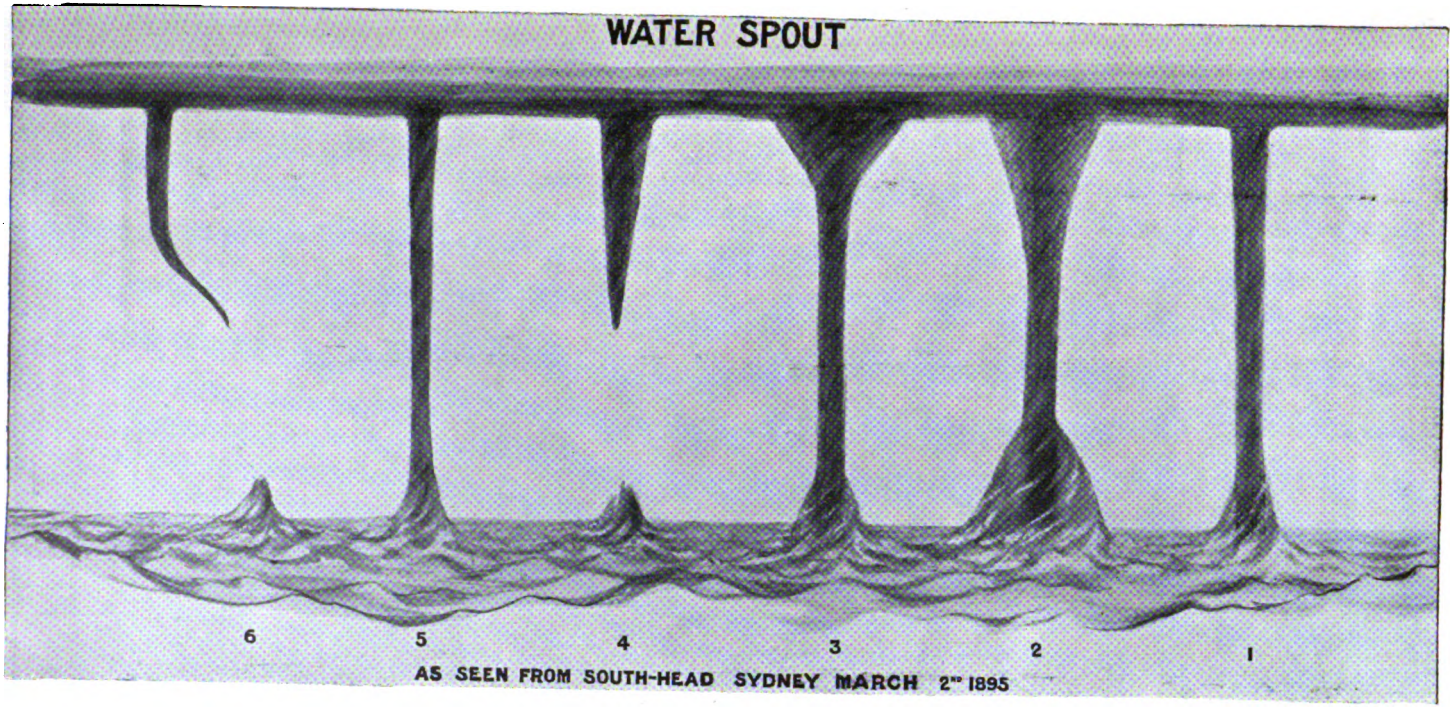
Digitized by Google

Digitized by Google



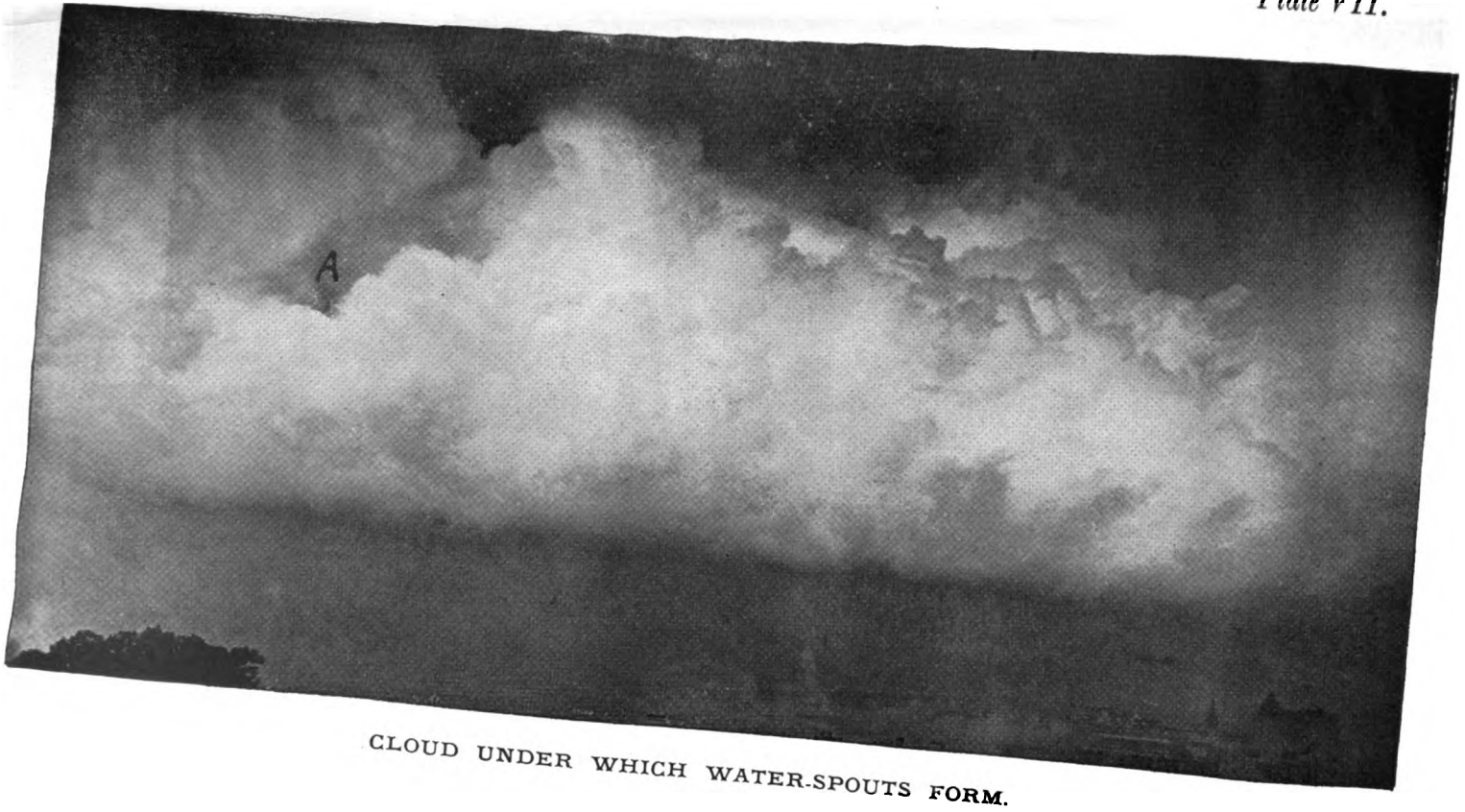
Digitized by Google

Digitized by Google



Digitized by Google

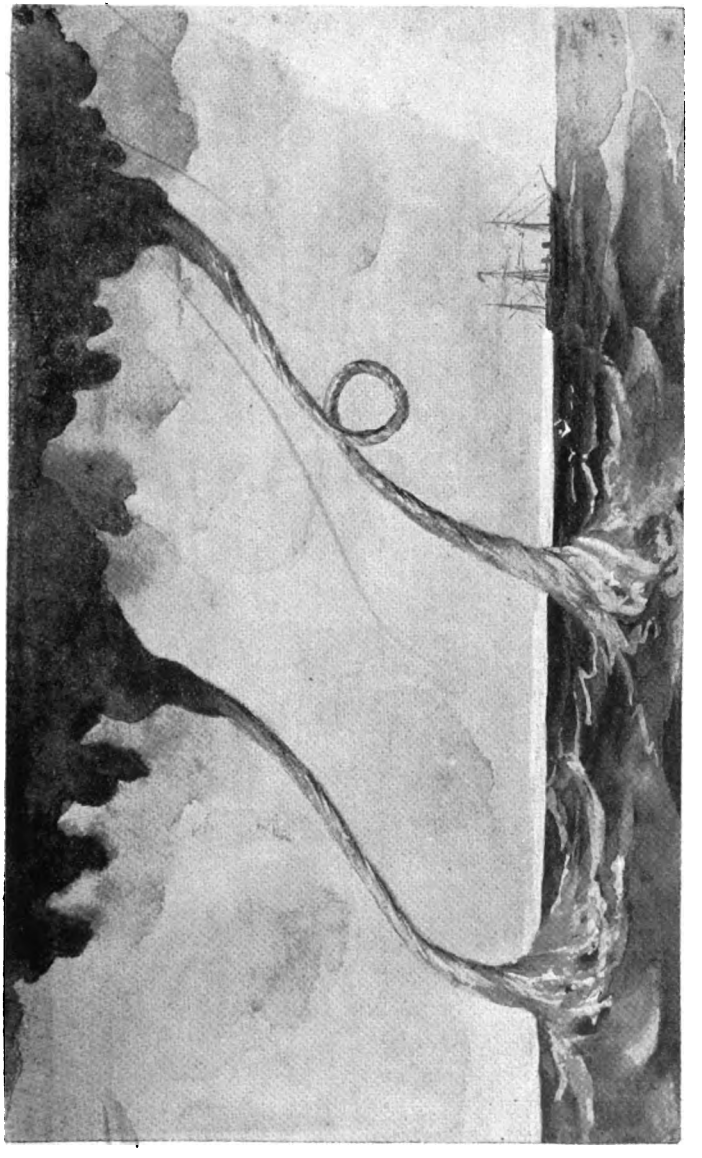
Digitized by Google



CLOUD UNDER WHICH WATER-SPOUTS FORM.

Digitized by Google

Digitized by Google



WATER-SPOUTS SEEN BY CAPT. TAPLIN.

Digitized by Google

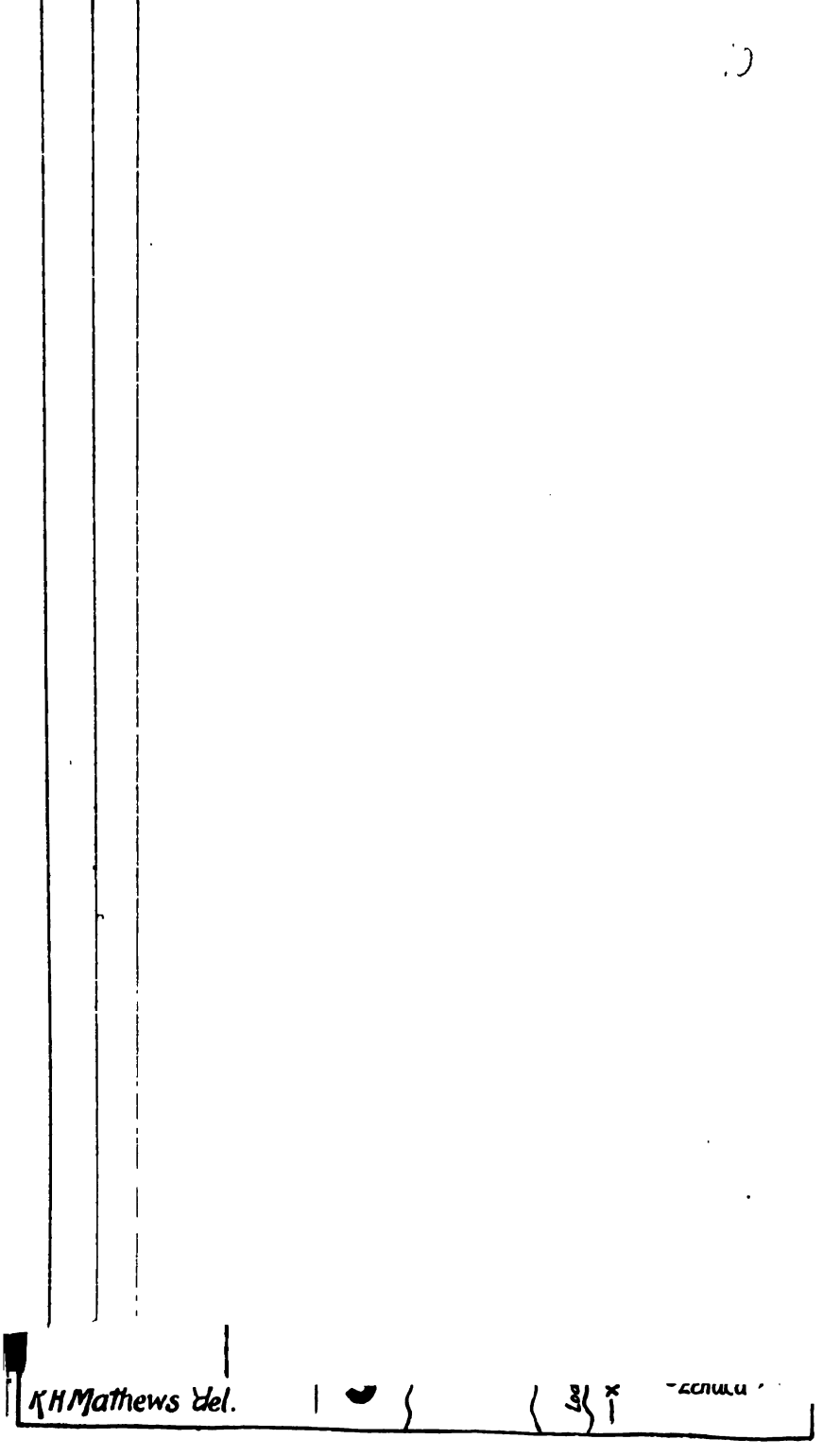
Digitized by Google



WATER-SPOUTS SEEN BY CAPT. TAPLIN.

Digitized by Google

Digitized by Google



Digitized by Google



Digitized by Google



Digitized by Google



Digitized by Google



Digitized by Google



Digitized by Google

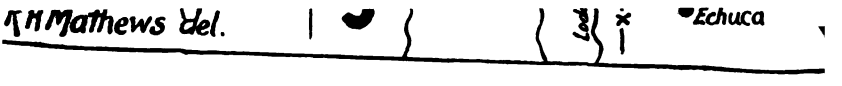


Digitized by Google

Digitized by Google

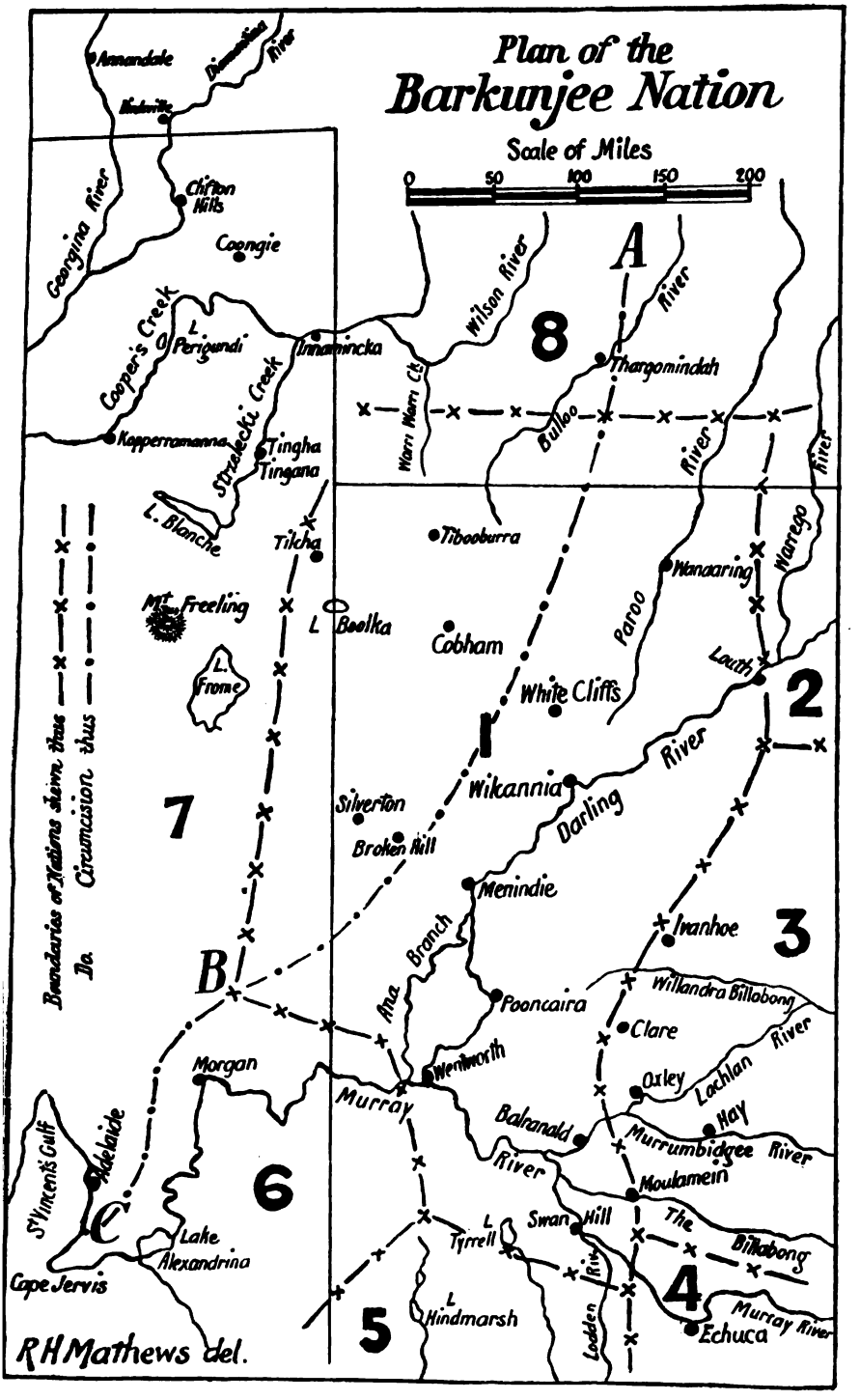
Digitized by Google

Digitized by Google



Digitized by Google

Digitized by Google



Digitized by Google

Digitized by Google

ABSTRACT OF PROCEEDINGS

Digitized by Google

Digitized by Google

ABSTRACT OF PROCEEDINGS

OF THE

Royal Society of New South Wales.

ABSTRACT OF PROCEEDINGS, MAY 4, 1898.

The Annual General Meeting of the Society was held at the Society's House, No. 5, Elizabeth-street North, on Wednesday evening, May 4th, 1898.

The President, HENRY DEANE, M.A., M. Inst. C.E., in the Chair.

Forty-five members and one visitor were present.

The minutes of the preceding meeting were read and confirmed.

The following Financial Statement for the year ended 31st March, 1898, was presented by the Hon. Treasurer, and adopted:

GENERAL ACCOUNT.

RECEIPTS.	£ s. d.	£ s. d.
Subscriptions: One Guinea	117 12 0	
Two Guineas	317 2 0	
Arrears	145 19 0	583 16 0
Advances	3 3 0	
Entrance Fees		27 6 0
Parliamentary Grant on Subscriptions received—		
1897		
June 15, Balance of Vote for 1896-97 ...	223 17 0	
1898		
Jan. 12, On account of Vote for 1897-98...	347 11 0	
		571 8 0
Rent...		14 0 0
Sundries		25 13 0
Total Receipts		1222 3 0
Balance on 1st April, 1897		14 6 11
[Outstanding Account, F. W. White £64 15s. 0d.]		£1236 9 11

Digitized by Google

Payments.	£	s.	d.	£	s.	d.
Advertisements	23	12	6			
Assistant Secretary	250	0	0			
Books and Periodicals	80	8	4			
Bookbinding	58	2	7			
Conversazione	58	2	7			
Collector	11	8	9			
Freight, Charges, Packing, &c....	10	0	0			
Furniture and Effects	27	5	1			
Gas	25	0	8			
Housekeeper	10	0	0			
Insurance	11	12	0			
Interest on Mortgage	63	0	0			
Office Boy	22	6	4			
Petty Cash Expenses	12	11	4			
Postage and Duty Stamps	30	0	0			
Printing	6	7	0			
Printing and Publishing Journal	384	7	6			
Rates	39	7	2			
Reception	15	15	6			
Refreshments and attendance at Meetings ...	24	11	6			
Repairs	2	6	6			
Stationery	3	8	0			
Sundries	24	14	6			
Total Payments				1194	7	10
Balance on 31st March, 1898, viz.:—						
Cash in Union Bank, General Account ...	24	1	7			
,, ,, B. & I. Fund ...	8	0	6			
Cash in hand...	10	0	0			
				42	2	1
				£1236	9	11

BUILDING AND INVESTMENT FUND.

Receipts.	£	s.	d.
Loan on Mortgage at 4½%	1400	0	0
Clarke Memorial Fund—			
Loan at current Savings Bank rate of interest	396	15	11
	£1796	15	11

Payments.	£	s.	d.
Advance to General Account 31st March, 1897	8	0	6
Balance 31st March, 1898	1788	15	5
	£1796	15	11

Digitized by Google

CLARKE MEMORIAL FUND.

Receipts.	£	s.	d.
Loan to Building and Invest. Fund, 1 Sept., and 12 Oct., 1896	376	7	9
Interest to 31 March, 1898	20	8	2
	£396	15	11

	£	s.	d.
Loan to Building and Investment Fund, March 31, 1898 ...	396	15	11
	£396	15	11

AUDITED AND FOUND CORRECT, DAVID FELL.
C. R. WALSH.

SYDNEY, 14th April, 1898.

H. G. A. WRIGHT, *Honorary Treasurer.*
W. H. WEBB, *Assistant Secretary.*

Messrs. G. R. Cowdery and Henry G. Smith were appointed Scrutineers, and Mr. C. W. Darley deputed to preside at the Ballot Box.

A ballot was then taken, and the following gentlemen were elected officers and members of Council for the current year :—

Honorary President:
HIS EXCELLENCY THE RIGHT HON. HENRY ROBERT VISCOUNT HAMPDEN.

President:
G. H. KNIBBS, F.R.A.S.

Vice-Presidents:
PROF. ANDERSON STUART, M.D. | PROF. T. W. E. DAVID, B.A., F.G.S.
PROF. THRELFALL, M.A. | HENRY DEANE, M.A., M. Inst. C.E.

Hon. Treasurer:
H. G. A. WRIGHT, M.R.C.S. *Eng.*, L.S.A. *Lond.*

Hon. Secretaries:
J. H. MAIDEN, F.L.S. | W. M. HAMLET, F.C.S., F.I.C.

Members of Council:
C. O. BURGE, M. Inst. C.E. | CHARLES MOORE, F.L.S.
E. B. DOCKER, M.A., D.C.J. | E. F. PITTMAN, Assoc. R.S.M.
J. W. GRIMSHAW, M. Inst. C.E. | F. H. QUAIFE, M.A., M.D.
H. A. LENEHAN, F.R.A.S. | H. C. RUSSELL, B.A., C.M.G., F.R.S.
Prof. LIVERSIDGE, M.A., LL.D., F.R.S. | PROF. WARREN, M. Inst. C.E., Wh.Sc.

Digitized by Google

The certificates of six candidates were read for the first time.

The following announcements were made:—

1. That the Society's Journal for 1897, Vol. XXXI., was in the hands of the binder, and would shortly be ready for delivery to members.

2. That the Officers and Committee of the Engineering Section had been elected for the ensuing Session, and the dates fixed for their meetings as follows:—

SECTION MEETINGS.

	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
ENGINEERING—Wednesday, (8 p.m.)	18	15	20	17	21	19	16	21

SECTIONAL COMMITTEES—SESSION 1898.

Section K.—Engineering.

Chairman—T. H. Houghton, M. Inst. C.E., M. Inst. M.E.

Secretary and Treasurer—S. H. Barraclough, M.M.E.

Committee—Henry Deane, M. Inst. C.E., T. R. Firth, M. Inst. C.E., W. Thow, M. Inst. C.E., M. Inst. M.E., H. R. Carleton, M. Inst. C.E., Norman Selfe, M. Inst. C.E., M. Inst. M.E., Percy Allan, Assoc. M. Inst. C.E., Assoc. M. Am. Soc. C.E.

Past Chairmen, *ex officio* Members of Committee for three years: B. C. Simpson, M. Inst. C.E., Prof. Warren, M. Inst. C.E., Wh. Sc., and C. O. Burge, M. Inst. C.E.

3. That the Officers and Committee of the Medical Section would be elected, and the dates fixed for their meetings on the 20th May.

On the motion of Mr. G. H. KNIBBS, seconded by Mr. JOSIAH MULLENS, it was resolved that the following proposed alterations to various Rules be agreed to *pro formâ*, and that the discussion upon the same take place at the next General Monthly Meeting in June.

Alterations to Rules, recommended by the Council, proposed at the Annual General Meeting, 4th May, 1898:—

RULE IV. (Page XV.) Third line, insert the word 'first' before 'General Meeting,' and after the word 'May' add the following: 'hereinafter called the Annual General Meeting."

Digitized by Google

RULE XII. (Page xviii.) First line, alter '1st' to 'first day.'

„ XIV. (Page xviii.) Seventh line, the word 'shall' to be altered to 'may.'

„ XIV. (Page xviii.) Ninth line, insert the word 'such' before 'arrears,' and after the word 'arrears' add 'as the Council may determine.'

„ XV. (Page xix.) Second line, the word 'requested' to be altered to 'required.'

„ XV. (Page xix.) Fifth line, after the word 'Society' add the following :—'and to pay all arrears of subscription due to the Society.'

„ XXI. (Page xxi.) First line, alter the word 'A' to 'The Annual,' and erase the word 'annually.'

„ XXV. (Page xxii.) Eighth line, after the word 'ordinary' insert the word 'general.'

„ XXXVI. (Page xxvi.) First line, after the word 'Vice-Presidents' the word 'Hon. Treasurer' to be inserted.

„ XLI. (Page xxvii.) Second line, after the word 'successive' insert the word 'Annual.'

Mr. HENRY DEANE, M.A., M. Inst. C.E., then read his address, which was divided into three parts dealing with :—

1. The affairs of the Society during the past twelve months.

2. Matters of interest that arose during the same period, especially in the Government Departments, Natural Science, and the meeting of the Australasian Association for the Advancement of Science.

3. The importance of Science and Scientific Education.

Part 1. The following matters were referred to :—The reduction in the roll of members and the increased expenditure of the Society; the members were urged to invite suitable persons in the community at large to join. Obituary: under which, amongst others, was Mr. Eddy, late Chief Commissioner for Railways; reference was made to the loss of Mr. John Whitton, who although

Digitized by Google

not a member of the Society, was closely identified with the progress of the Colony, especially as regards railways. The work done at the monthly meetings of the Society and Sections; the Reception held last July and the Conversazione in January were mentioned in addition to some other matters.

Part 2. This part dealt with the principal work done during the year outside the Society, general routine work being excluded. Special attention was invited to electrical tramways, to the newly discovered system of septic treatment of sewage, to artesian bores as inducing settlement of population in the north-west, and to the meeting of the Australasian Association for the Advancement of Science last January.

Part 3. The importance of science and scientific education was dealt with at some length, and the President pointed out the misconceptions that prevail as to what science really is, while some people looked on it as a harmless but somewhat contemptible triviality, others as uninteresting and abstruse and beyond their comprehension. The erroneous nature of these ideas was pointed out and the further dissemination of scientific knowledge advocated. Attention was specially drawn to the importance of technical training to all those engaged in the mechanical and manufacturing arts, from the employer through all grades down to the workman.

The President concluded by advocating greater sympathy being encouraged between teacher and student, especially in the case of large classes. This has reference not only to Universities, but to other educational institutions where similar conditions prevail. By the introduction of more complete intercourse the President had no doubt that results would far exceed those at present obtained.

A vote of thanks was passed to the retiring President, the Hon. Secretaries and Hon. Treasurer, and Mr. G. H. KNIBBS, F.R.A.S., was installed as President for the ensuing year.

Mr. KNIBBS thanked the members for the honour conferred upon him.

Digitized by Google

ABSTRACT OF PROCEEDINGS, JUNE 1, 1898.

The General Monthly Meeting of the Society was held at the Society's House, No. 5 Elizabeth-street North, on Wednesday evening, June 1st, 1898.

The President, G. H. KNIBBS, F.R.A.S., in the Chair.

Thirty members and one visitor were present.

The minutes of the preceding meeting were read and confirmed.

The certificates of six candidates were read for the second time.

The Chairman announced :—

1. That the Society's Journal for 1897, Vol. XXXI., was ready for delivery, and any member entitled to the same could obtain a copy on application to the Assistant Secretary.

2. That the Officers and Committee of the Medical Section had been elected for the ensuing Session and the dates fixed for their meetings as follows :—

SECTION MEETINGS.

	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
MEDICAL—Friday, (8·15 p.m,)...	20	17	15	19	16	21	18	16

SECTIONAL COMMITTEES—SESSION 1898.

Section H.—Medical.

Chairman—G. E. Rennie, B.A. *Syd.*, M.D. *Lond.*, J.P.

Hon. Secretaries—J. Adam Dick, B.A. *Syd.*, M.D. *Edin.*, and F. Tidswell, M.B. *Syd.*, and D.P.H., *Camb.*

Committee—Sydney Jamieson, B.A. *Syd.*, M.B., C.M. *Edin.*, M.R.C.S., *Eng.*, G. Lane Mullins, M.A., M.D., *Dub.*, F. H. Quaife, M.A.M.D.,C.M., *Glas.*, J. Ashburton Thompson, M.D. *Brux.*, D.P.H. *Camb.*, M.R.C.S. *Eng.*

Meetings held on the Third Friday in each Month, at 8·15 p.m.

(Provided sufficient material is obtainable.)

A memorandum on the nature and progress of work carried out at The Imperial Institute, London, with illustrations of practical results attained, or in progress, from information supplied by the Commercial and Industrial Intelligence Office, and by the Scientific and Technical Department of the Imperial Institute, was brought under the notice of the members.

Digitized by Google

The alterations to the following rules proposed at the Annual General Meeting, 4th May, 1898, were agreed to, viz.:—Rules IV., XII., XIV., XV., XXI., XXV., and XXXVI., and the following amendment to Rule XLI. was carried, viz.:—"To insert instead of the words 'two successive general meetings,' the words 'one ordinary general meeting, and confirmed at the next Annual General Meeting.'"

THE FOLLOWING PAPERS WERE READ:—

1. "Paper on *Aeronautics*," by LAWRENCE HARGRAVE.

The author describes at length, with scale drawing and photographs, a kite that under favourable circumstances will soar horizontally and at various acute angles to the direction of the wind. The kite is of the well known cellular form but in addition has a bent piece of vulcanite nearly midway between the cells. This is called the propeller, and its effect is to create a vortex that acts on its under and concave side. The vortex pushes against the propeller in the same manner that the ball of a water nozzle draws against the orifice from which the water is issuing. The kite is heavily ballasted with lead, and weighs 1·9 lbs. for every square foot of area. Three methods of soaring are described, and eight points that require investigation are indicated for the guidance of anyone who has the leisure and sufficient interest in the subject to assist in the work. The paper also contains a short description of a pipe boiler and screw engine that is intended to drive a flying machine, and also the proposed arrangement of aeroplanes for supporting it, with the method of ensuring a safe trial.

2. "Australian Divisional Systems," by R. H. MATHEWS, L.S.

The author pointed out that all tribes of Australian Aborigines are divided into two exogamous intermarrying groups—the men of one group marrying the women of the other group. These tribal divisions have been designated organisations or systems. The names of the groups may change with the languages of the people in different districts, but the same system prevails in them all.

Digitized by Google

Besides these segregation into groups, there is a further subdivision of the latter into smaller segments, bearing the names of animals, such as kangaroo, iguana, emu, cod-fish, frog, etc. These animal names have been called *totems*, a word in use for the same purpose among the North American Indians. Mr. Mathews then proceeded to give an exhaustive description of the rules of marriage and descent established in relation to the divisions referred to, selecting examples from various native tribes located in districts widely separated from each other in different parts of Australia.

3. "Artesian Waters in New South Wales," by J. W. BOULTBEE.

The paper describes briefly the initial efforts at artesian boring in this colony, and leads up to the utilization of the water for irrigation purposes; it describes the work in that direction undertaken by the Government at the Native Dog and Pera Bores, and hints at the possibilities in the way of close settlement in small areas near to population centres. It points out how the Government was guided by American experience, and refers to the areas, soil, water, results, and the revolution effected in some of the States, and the rapid growth of settlement by means of the artesian water supply; it refers to the gradual awakening of our western pastoralists to the benefits conferred. The progress of the work in New South Wales, cost, yield of water etc., is tabulated. The advance in geological knowledge of the subject, and the more important developments in this branch are referred to. A new boring machine, "The Calyx," and the provisions of the Artesian Wells Act, 1897, are discussed. The paper emphasizes the vast possibilities of the question, and concludes that this colony now is in the same position in regard to it as America was twenty-seven years ago.

The following donations were laid upon the table and acknowledged :—

TRANSACTIONS, JOURNALS, REPORTS, &c.

(The Names of the Donors are in *Italics*)

ANNAPOLIS, M.D.—U. S. Naval Institute. Proceedings, Vol. XXII., No. 3, 1896; Vol. XXIII., Nos. 3, 4, 1897. *The Institute*

Digitized by Google

BALTIMORE—Johns Hopkins University. Circulars, Vol. XVII., Nos. 132, 133, 1897. *The University*

BIRMINGHAM—Birmingham and Midland Institute. Programme for Session 1897-98. Report of the Council for the year 1897. An address delivered in the Town Hall, Birmingham, 18 Oct. 1897, by Frederic Harrison, M.A., "The Millenary of King Alfred." *The Institute*

CAMBRIDGE—Cambridge Philosophical Society. Proceedings, Vol. IX., Parts vi., vii.. 1897. Transactions, Vol. XVI., Parts ii., iii., 1897-98. *The Society*

LEEDS—Yorkshire College. Annual Report, (23rd) 1896-7. *The College*

LONDON—British Museum (Natural History). A Guide to the Fossil Invertebrates and Plants in the Department of Geology and Palæontology, 1897. *The Museum*

Geological Society. Quarterly Journal, Vol. LIII., Part iv., No. 212, 1897; Vol. LIV., Part i., No. 213, 1898. Geological Literature added to the Library during the year 1897. List of the Geological Society of London, 2 Nov. 1897. *The Society*

Institute of Chemistry of Great Britain and Ireland. Proceedings, Parts i., ii., 1897. Bye-Laws, Charter of Incorporation, Regulations for Admission to Membership, and Register of Fellows, Associates and Students. *The Institute*

Institution of Civil Engineers. Minutes of Proceedings, Vol. CXXX., Part iv., 1896-97. Brief Subject Index, Vols. CIX. – CXXX., Sessions 1894-95 – 1896-97. *The Institution*

Institution of Mechanical Engineers. Proceedings, Nos. 1 and 2, 1897. ,,

Iron and Steel Institute. Journal, Vol. LII., No. 2, 1897. *The Institute*

Linnean Society. Journal, Botany, Vol. XXXIII., No. 229; Zoology, Vol. XXVI., No. 168. Proceedings, Nov. 1896 to June 1897. *The Society*

Mineralogical Society. *Mineralogical Magazine*, Vol. XI., No. 53, 1897. ,,

Pharmaceutical Society of Great Britain. Calendar, 1898. Pharmaceutical Journal, Vol. V., Fourth Series, Nos. 1427 – 1435, 1897; Vol. VI., Fourth Series, Nos. 1436 – 1447, 1898. ,,

Physical Society of London. Proceedings, Vol. XV., Parts ix. – xi., Nos. 84 – 86, 1897. ,,

Royal Agricultural Society of England. Journal, Third Series, Vol. VIII., Part iv., No. 32, 1897. ,,

Royal Astronomical Society. Monthly Notices, Vol. LVIII., Nos. 2, 3, 4, 1897-98. ,,

Royal College of Physicians. List of the Fellows, Members, Extra Licentiates and Licentiates, 1898. *The College*

Royal Geographical Society. *The Geographical Journal*, Vol. XI., Nos. 1, 2, 3, 1898. Year Book and Record 1898. *The Society*

Royal Historical Society. Transactions, New Series, Vol. XI., 1897. ,,

Digitized by Google

ABSTRACT OF PROCEEDINGS, JULY 6, 1898.

The General Monthly Meeting of the Society was held at the Society's House, No. 5 Elizabeth-street North, on Wednesday evening, July 6th, 1898.

The President, G. H. KNIBBS, F.R.A.S., in the Chair.

Twenty-eight members and two visitors were present.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were duly elected ordinary members of the Society:—

Beale, Charles Griffin; 109 Pitt-street.
Boyd, Robert James, B.E. *Univ. Syd.*; Terara.
Gurney, Elliott Henry; Petersham.
Smith, S. Hague; 81 Pitt-street.
Wark, William; 9 Macquarie Place.
Wildridge, John, M.I.M.E.; 97 Pitt-street.

The certificates of three candidates were read for the first time.

THE FOLLOWING PAPERS WERE READ:—

1. "On the Stringybark trees of New South Wales, especially in regard to their essential oils," by R. T. BAKER, F.L.S., and HENRY G. SMITH, F.C.S., Technological Museum. Part I.

This paper is the authors' third contribution to a knowledge of the essential oils of the genus Eucalyptus. Some notes on the classification of the species of this genus by other authors are given, and the species now investigated are arranged according to their chemical, economic, and botanical affinities. It was shown that the essential oil of the Red Stringybark, *E. macrorhyncha* besides containing a large percentage of eudesmol (the stearoptene of eucalyptus oil) gives an oil of excellent quality containing over fifty per cent. of eucalyptol, and answering all the requirements of the British Pharmacopoeia with the exception of that of specific gravity. The authors point out that by fixing the specific gravity of an Eucalyptus oil as high as 0·910 excellent oils might be considered as of inferior quality, while

Digitized by Google

inferior oils might pass the test, and they suggest that if the provision was made that a Eucalyptus oil should contain fifty per cent. of eucalyptol in addition to the other tests given in the Pharmacopoeia that the specific gravity test might be reduced to 0·900 – 0·925. The presence of such a large quantity of eudesmol in the oil may probably account for the peculiarity of this oil, as the low specific gravity is evidently caused by the presence of a terpene of low specific gravity, the eucalyptol when isolated being found to have the usual specific gravity of that substance. The importance of this matter of specific gravity was pointed out because most probably the oil will be eventually distilled in large quantities, when it is expected that it will be obtained as a bye-product in connection with the extraction of myrticolorin. Three methods were described in the paper for the preparation of eudesmol. The authors also show that the presence of such a large percentage of eudesmol in the oil, prevents to a very large extent the reaction for eucalyptol with phosphoric acid, and that the method could not be used for the quantitative determination of eucalyptol in the crude oil of this species. The oil of that Stringybark called by the authors Brown Stringybark, *(E. capitellata)* was found to resemble much that of the previous species, but does not appear to contain eudesmol. The oil of the White Stringybark *(E. eugenioides)* answers all the requirements of the British Pharmacopoeia.

2. "On Current observations on the Canadian-Australian route," by Capt. CAMPBELL HEPWORTH, R.M.S. *Aorangi*.

This paper purposed to shew by observations of ocean current made during sixty-four passages between Australia and British Columbia in the liners *Aorangi*, *Warrimoo*, and *Miowera*, the general set and strengths of the currents which are experienced, according to the season of the year, by vessels making the passage between these two colonies. The paper was illustrated by twelve charts, one for each month of the year, on which was delineated each current observation recorded, amounting to several thousand

Digitized by Google

observations. It will be readily understood that safe and successful navigation depends largely on a knowledge of the movements of the sea surface drifts and the path of the main ocean streams, and it is with the object of adding to such scanty information upon the subject as has been obtainable hitherto, that the author compiled his paper. In a far more comprehensive form the Hydrographical Office purposes to publish current charts of the Pacific Ocean, and to quote Capt. Hepworth's words, "then these records of ocean current with which I have been dealing, the study of which has appeared to me somewhat like the perusal of stray fragments of a torn up document, will have complete contexture, and it will be known whether the theories adopted by me in their interpretation be correct or otherwise, but in the meantime it is hoped they will be of some value to the navigators of the Pacific."

The reading of the paper on "A group of Water-spouts" by H. C. Russell, B.A., C.M.G., F.R.S., was postponed till the next meeting.

EXHIBITS.

1. Mr. R. A. Bastow, Fitzroy, Victoria, exhibited a key to tribes and genera of Melanospermæ (olive-green or brown algæ) which he had prepared for the use of students. This key will be reproduced by photo-lithography in the same size as the original drawing, and will form Plate 1 in the Society's Journal for 1898, Vol. xxxii.

2. A facsimile (in metal, presented by the Trustees of the Public Library of New South Wales) of the Tablet erected on Inscription Point near Cape Solander, the southern head of Botany Bay. The original was affixed to commemorate the foundation of the Philosophical Society of Australasia in 1821 (the precursor of our Society) and as a record of the landing-place of Cook and Banks in Botany Bay in 1770.

The following donations were laid upon the table and acknowledged :—

Digitized by Google

TRANSACTIONS, JOURNALS, REPORTS, &c.

(The Names of the Donors are in *Italics*).

AACHEN—Meteorologische Station I. Ordnung. Deutsches Meteorologisches Jahrbuch für 1896. *The Director*

ADELAIDE—Royal Society of South Australia. Transactions, Vol. XX., Part ii., 1896. *The Society*

University. Calendar for 1897. *The University*

BERLIN—Gesellschaft für Erdkunde. Verhandlungen, Band XXIV., Nos. 4–7, 1897. Zeitschrift, Band XXXII., Nos. 2–4, 1897. *The Society*

Königlich preussische Akademie der Wissenschaften. Sitzungsberichte, Nos. 40 - 53, 1897. *The Academy*

Königlich preussische Meteorologische Instituts. Ergebnisse Beobachtungen an den Stationen II. und III. Ordnung im Jahre 1897, Heft 1. Die Feier des fünfzigjahrigen Bestehens am 16 Oktober 1897. *The Institute*

BOSTON, Mass.—American Academy of Arts and Sciences. Proceedings, Vol. XXXII., Nos. 16, 17; Vol. XXXIII., Nos. 1–8, 1897. *The Academy*

Boston Society of Natural History. Proceedings, Vol. XXVIII., Nos. 1–5, 1897. *The Society*

BROOKVILLE—Indiana Academy of Science. Proceedings, 1896. *The Academy*

CAMBRIDGE (Mass.)—Museum of Comparative Zoölogy at Harvard College. Annual Report of the Curator for 1896-97. Bulletin, Vol. XXXI., Nos. 1–6, 1897-98. Memoirs, Vol. XXIII., No. 1, 1897. *The Museum*

CHICAGO—Field Columbian Museum. Second Annual Exchange Catalogue for the year 1897-98. Publications 21, 22, 24. „

CINCINNATI—Cincinnati Society of Natural History. Journal. Vol. XIX., No. 3, 1897. *The Society*

DENVER—Colorado Scientific Society. Bulletin, Nos. 10, 11, 1897; No. 1, 1898. Papers read before the Society Nov. 6, 1897 and Feb. 5, 1898. „

DUBLIN—Royal Dublin Society. Scientific Proceedings, N.S., Vol. VIII., Part v., 1897. Scientific Transactions, Ser. 2, Vol. V., Part xiii., 1896; Vol. VI., Parts ii. – xiii., 1896-7. „

Royal Irish Academy. Proceedings, Third Series, Vol. IV., No. 4, 1897. *The Academy*

EDINBURGH—Edinburgh Geological Society. Transactions, Vol. VII., Part iii., 1895-96. Roll of Members, 31 Dec. 1897. The Laws of the Edinburgh Geological Society, 31 Oct. 1897. *The Society*

Royal Scottish Geographical Society. *Scottish Geographical Magazine*, Vol. XIII., Nos. 10, 11, 12, 1897; Vol. XIV., Nos. 1, 2, 3, 1898. „

FORT MONROE, Va.—U. S. Artillery School. Journal of the U.S. Artillery, Vol. VIII., Nos. 2, 3, 1897; Vol. IX., No. 1. 1898. *The School*

Digitized by Google

ABSTRACT OF PROCEEDINGS, AUGUST 3, 1898.

The General Monthly Meeting of the Society was held at the Society's House, No. 5 Elizabeth-street North, on Wednesday evening, August 3rd, 1898.

The President, G. H. KNIBBS, F.R.A.S., in the Chair.

Twenty-four members were present.

The minutes of the preceding meeting were read and confirmed.

Two new members enrolled their names and were introduced.

The certificates of three candidates were read for the second time, and of three for the first time.

The President made the following announcements:—

1. That it was necessary and customary for authors to furnish the Hon. Secretaries with short abstracts of their papers prior to being read before the Society, such being required both for Press purposes and for the printed monthly abstract of Proceedings.

2. That at the last meeting of the Council it had been decided to obtain for the convenience of the members of the Society the complete International Scientific catalogue. Students of Science are familiar with the bibliographical difficulties which beset every attempt to obtain complete information of the state of any branch of Science, and the formation of an International catalogue, in which will be set forth immediately, every publication in Science throughout the length and breadth of the world, is a boon, the value of which it is impossible to overestimate. He need hardly say that the decision of the Council in respect of this matter will be very heartily appreciated by every student or investigator in our membership: the opportunity of easily becoming acquainted with every accession of scientific knowledge is now within measurable distance, and it is to be hoped that a corresponding stimulus will be given here to scientific research without which we hardly take our place in the civilized world.

Digitized by Google

3. The Council of the Physico-Economical Society (Der Vorstand der Physikalisch Gesellschaft) Könisberg i. Pr., offer a prize of 4,000 marks (£200), for "a work which brings to light either the province of vegetable or animal electricity or fundamentally new phenomena, or furnishing essentially new conclusions touching the physical cause of organic electricity or its significance for life generally or for definite functions." The essay may be printed or written in German, French, English, or Italian, and must reach the Council before 31st December 1900, and must in no case be published prior to 30th September, 1898. The author may remain anonymous by giving a title to his paper and enclosing his name and address in an envelope. In case no essay is deemed of sufficient merit, two lesser prizes of 500 marks (£25) will be awarded to the worthiest works. The result will be announced at the General Meeting of the Society, 6th June, 1901.

THE FOLLOWING PAPERS WERE READ :—

1. "Water-spouts on the Coast of New South Wales," by H. C. Russell, B.A., C.M.G., F.R.S.

The paper dealt chiefly with the group of twenty water-spouts seen at Eden, on May 16th. It was shewn that one of these water-spouts was 5,000 feet high, as measured with a theodolite. The longest off Sydney Heads was 400 feet; here the greater number observed are even less than 400 feet. It was shewn that water-spouts always form under massive rain clouds, and that they seldom, if ever, last for an hour. The author endeavoured to prove that the water did not go up the centre of the spout, but followed spirally the outside of it, and that the quantity of salt water going up cannot be so much as supposed, because there is no instance on record where *salt rain* fell after a water-spout. For the observation of water-spouts Mr. Russell is indebted chiefly to Mr. Crichton, Mining Engineer, Eden; to Dr. A. W. Morgan, Pambula; to Mr. Newton, Pilot, Eden; and to Mr. Francis, Signal Master, Sydney.

Digitized by Google

2. "Some Physical Properties of Nickel Steel," by W. H. WARREN, Wh. Sc., M. Inst. C. E., Challis Professor of Engineering, and S. H. BARRACLOUGH, M.M.E., Assoc. M. Inst. C.E., Lecturer in Mechanical Engineering, University of Sydney.

Nickel steel, hitherto employed chiefly in the manufacture of armour plates, and to a less extent, in forgings for certain important parts of machinery, will probably have a greatly extended use as its physical properties become better known, and the cost of its production lessened. The present paper describes a series of tests of specimens of three varieties of nickel steel manufactured by the firm of Fried. Krupp, of Essen, Germany, the three varieties being known as 'mild,' 'medium,' and 'non-rusting,' and containing respectively, three, eight and twenty-five per cent. of nickel. After summarising the present state of our knowledge of the material, the authors describe their experiments to determine the tensile and compressive strengths, limit and coëfficient of elasticity, percentage elongation and contraction of area, yield point, torsional strength, shearing strength, and relative liability to corrosion. Detailed tables of the observations for each experiment accompany the paper, and, in order to supply a basis for comparison, especially as regards the elastic limits, a summary of results obtained from similar tests of specimens cut from a Vicker's axle is attached.

NOTES AND EXHIBITS.

Professor ANDERSON STUART, M.D., University of Sydney, exhibited a preparation of the human ear showing a new mode of demonstrating the action of the auditory ossicles. The method consists in removing the roof of the tympanic cavity so as to fully expose its contents. A glass tube is now tied into the external auditory meatus. To this tube is attached a rubber tube about a foot long, and through these tubes the demonstrator by his mouth can force air into, and suck air out of, the external meatus. Thus the tympanic membrane is made to move, carrying with it the ossicles in the same sort of movement as in the normal action of the parts, the only essential difference being that this movement

Digitized by Google

is greatly exaggerated. It is best observed by the aid of a hand lens.

Mr. L. HARGRAVE exhibited two Soaring Kites M. and N.—

Two Soaring Kites.	M	N.
Length	4′ 11″	4′ 1½″
Width	3′ 3¾″	3′ 0″
Projected area of propeller	371 sq. in.	243 sq. in.
„ „ end surfaces ...	144 „	128 „
Total area, square feet	3·58	2·58
Weight, pounds	5·63	4·09
Pounds weight per square foot ...	1·57	1·59
Angle of propeller	− 4½°	− 3°

(1) The bed rock of this matter is the fact that the wind blowing on the convex side of a soaring curve, causes a thrust on the concave side in a direction to windward of the zenith.

(2) The soaring curve pulls the plane part of the kite up against the wind, resulting in a motion against the wind. This is the converse of the act of pulling in the string of a kite to make it come forward and down.

(3) The soaring bird's wing may be divided into three triangles, two of which soar, and one acts as a kite wrong side up.

(4) A bird that is merely soaring by means of an upward trend of wind may be known by the wing tips being turned up.

(5) A bird that is truly soaring in horizontal or downward blowing wind, may be known by the wing tips drooping.

Prof. LIVERSIDGE, M.A., LL.D., F.R.S., exhibited and described (1) some Maori net sinkers made of impure barytes (sp. gr. 4·03) and of claystone? (sp. gr. 2·8) and some unworked concretionary nodules of barytes, these had been obtained by Mr. John Webster of Hokianga, New Zealand, from some kitchen middens in the district. The Maoris had doubtless selected the barytes on account of its great density; its comparative softness allowed it to be readily worked into shape and perforated. This is the only case, known to the exhibitor, of barytes being used for this purpose.

Digitized by Google

(2) *Sections of Silver and Copper Nuggets.*—The nugget of native silver from Lake Superior, was not very much water-worn. It contained a little calcite and some quartz in cavities, also a little native copper. On slicing, polishing and etching it with dilute nitric acid it presented a strongly marked crystalline structure closely resembling that seen in the West Australian gold nuggets, figured in the Journ. Roy. Soc. N.S.W., 1897.

A nugget of copper from Lake Superior, although studded with crystals of silver externally, showed none in the etched section. The silver crystals were imperfect rhombic dodecahedra about one-eight inch across. This nugget of copper, as well as others, from Bolivia and from Burra Burra, South Australia, showed an internal crystalline structure somewhat similar to that of the West Australian gold nuggets already referred to, but the crystals nearly always radiate out from one or more centres, this was not observed in any of the gold nuggets.

(3) *Stalactites and Stalagmites* from the tunnel at the Prospect Reservoir; these were collected by Mr. E. Hufton of the Chemical Laboratory; the tunnel was built some twelve? years ago, and the comparatively large size of the stalagmitic deposit—nearly two inches in thickness—gives an idea of the rate of deposition of calcium carbonate. The exhibitor believes they have been derived mainly from the cement of the tunnel, inasmuch as he understands that no limestone was used in its construction, nor is there any in or about the reservoir. The catchment area is essentially of sandstone and the water consequently poor in lime.

Mr. J. F. Mann desires to make the following remarks on the paper "Native Names of some of the Runs &c. in the Lachlan District," by F. B. W. Woolrych (this Journ. xxiv., 63) communicated by him. "On pages 65, 66, I make it appear that *Cowal Bugon* is the correct native name for the extensive lake or swamp locally known as Cowal Lake; this statement is correct only to a certain extent, and requires further explanation.

"In the early days of settlement all swampy places were densely covered with rushes, since greatly destroyed by cattle; at certain

Digitized by Google

seasons these rushes were occupied or visited by a species of moth called by the natives *Bugon* or *Bugong;* they abounded in swamps and were no doubt connected in some way with the numerous gossamer webs also found in abundance amongst the rushes. These moths, though small, were occasionally collected by the natives as an article of food, an entrement only, and the expression *Cowal Bugon* indicated the intention of one or more of these natives of visiting this lake for the purpose of collecting these insects; had the object been otherwise, such as seeking water-fowl or their eggs, the significant name for that particular item would have been used in place of the word "Bugon."

"Cowal, as I have already explained, means large; I cannot at present give the tribal name for water, lake, or swamp; there are several names for these, so as to distinguish good drinking water from that which is bad, also smooth water from that flowing over a rocky bed, etc.

"The word Bugon is applied also to the moths found in numbers at Mount Kosciusko, but I am unable to say whether they are identical with those of the Lachlan district; doubtless local influences cause some difference.

"Many years ago while scaling some steep cliffs of Hawkesbury Sandstone, situated at an elevation of at least 3,000 feet, at the head of the Cudgegong River, I was nearly smothered by a swarm of moths which suddenly issued from a cave or recess in the rocks, these I conclude were more closely allied to the Kosciusko moth than those of the Lachlan River.

"I have grave doubts as to the genuiness of the name "Bumbaldry" (p. 65); taken in connection with the interpretation thereof, I am inclined to think that it is the result of some poetically inspired early settler on viewing a number of naked aborigines taking headers into the pool of water on Tyagong Creek.

"In conclusion, I may here note that, in the early days when the natives were numerous, the arrangements in a 'camp proper,' that is, when it comprised the bulk of a tribe, were carried on

Digitized by Google

with systematic regularity, and the disposal of the men for the ensuing day or days was a matter always for consideration."

The following donations were laid upon the table and acknowledged :—

TRANSACTIONS, JOURNALS, REPORTS, &c.

(The Names of the Donors are in *Italics*.)

BOLOGNA—R. Accademia delle Scienze dell' Istituto di Bologna. Rendiconto, Nuova Serie, Vol. I., 1896-97. Memorie, Serie V., Tome V., 1895-96. *The Academy*

BONN—Naturhistorische Vereins der preussischen Rheinlande, Westfalens und des Reg.-Bezirks Osnabrück. Verhandlungen, Jahrgang LIV., Hälfte 1, 1897. *The Society*

Niederrheinische Gesellschaft für Natur-und Heilkunde. Sitzungsberichte, Hälfte 1, 1897. ,,

BRAUNSCHWEIG—Vereins fur Naturwisenschaft. Jahresbericht, Vol. X., 1895-97. Braunschweig im Jahre 1897. ,,

BRISBANE—Royal Society of Queensland. Proceedings, Vol. XIII., 1897-8. ,,

CAEN—Académie Nationale des Sciences, Arts et Belles-Lettres. Mémoires 1896. *The Academy*

CARLSRUHE—Grossherzoglich-Badische Technische Hochschule. Programm für das Studienjahr 1897-8. Inaugural Dissertations (2) *The Director*

CRACOW—Académie des Sciences. Bulletin International, Nos. 3–10, 1897; No. 1, 1898. *The Academy*

FLORENCE—Società Italiana di Antropologia, Etnologia &c. Archivio, Vol. XXVII., Fasc 2, 1897. *The Society*

Società di Studii Geografici e Coloniali. Bullettino, Annata IV., Fasc. 9, 10, 1897; Annata V., Fasc. 1 - 3, 1898. ,,

FRANKFURT A/M—Senckenbergische Naturforschende Gesellschaft Abhandlungen, Band XX., Heft 1, 1897; Band XXIII., Heft 3, 4, 1897. Bericht für 1897. ,,

FREIBERG i.S.—Königlich-Sächsische Bergakademie. Jahrbuch für das Berg-und Hüttenwesen im Königreiche Sachsen auf das Jahr 1897. *The Academy*

GLASGOW—Philosophical Society of Glasgow. Proceedings, Vol. XXVIII., 1896-97. *The Society*

GÖTTINGEN—Königliche Gesellschaft der Wissenschaften. Nachrichten, Geschäftliche Mittheilungen Heft 2, 1897. Mathematisch-physikalische Klasse Heft 3, 1897. ,,

HALIFAX, N.S.—Nova Scotian Institute of Science. Proceedings and Transactions, Vol. IX., Part 3, 1896-97. *The Institute*

HAMBURG—Deutsche Seewarte. Ergebnisse der Meteorologischen Beobachtungen. Jahrgang XIX., 1896 und für das Dezennium 1886 - 1895. *The Observatory*

Naturhistorisches Museum. Mitteilungen, Jahrgang XIV., 1897. *The Museum*

Digitized by Google

HAMILTON (Ont.)—Hamilton Association. Journal and Proceedings, Vol. XVIII., 1896-97. *The Association*

HAVRE—Société Géologique de Normandie. Bulletin, Tome XVII., Années 1894-9. *The Society*

LEIPZIG—Königl. Sächsische Gesellschaft der Wissenschaften. Berichte, Math.-phys. Classe No. 4, 1897. Sachregister der Abhandlungen und Berichte 1897. ,,

LILLE—Société Géologique du Nord. Annales, Tome XXIV., 1896. ,,

LONDON—Anthropological Institute of Great Britain and Ireland. Journal, Vol. XXVII., No. 2, 1897; No. 3, 1898. *The Institute*

British Museum (Natural History). Catalogue of the African Plants collected by Dr. Friedrich Welwitsch in 1853 - 61—Dicotyledons Part i. Catalogue of the Fossil Bryozoa in the Department of Geology—The Jurassic Bryozoa by J. W. Gregory, D.Sc. *The Museum*

Geological Society. Quarterly Journal, Vol. LIV., Part ii., No. 214, 1898. *The Society*

Institution of Mechanical Engineers. Proceedings, No. 4, 1896. *The Institution*

Institution of Naval Architects. Transactions, Vols. XXXVI., XXXVIII., XXXIX., 1895-97. *The Institution*

Linnean Society. Journal, Botany, Vol. XXXIII., No. 230. List of Fellows 1897-98. *The Society*

Meteorological Office. Meteorological Observations at Stations of the Second Order for the year 1894. Report of the Meteorological Council for the year ending 30th March, 1897. *The Office*

Pharmaceutical Society of Great Britain. Pharmaceutical Journal, Ser. 4, Vol. VI., Nos. 1448 - 1458, 1460, 1461, 1898. *The Society*

Quekett Microscopical Club. Journal, Ser. II., Vol. VI., No. 41, 1897. *The Club*

Royal Agricultural Society of England. Journal, Third Series, Vol. IX., Part i., No. 33, 1898. *The Society*

Royal Astronomical Society. Monthly Notices, Vol. LVII., No. 9, Supplementary Number; Vol. LVIII., Nos. 1 - 7, 1897-8. ,,

Royal Geographical Society. *The Geographical Journal*, Vol. X., Nos. 4 - 6, 1897; Vol. XI., Nos. 4 - 6, 1898. ,,

Royal Meteorological Society. Quarterly Journal, Vol. XXIII., 1897; Vol. XXIV., Nos. 105, 106, 1898. Meteorological Record, Vol. XVII., Nos. 65 - 67, 1897. List of Fellows, Feb. 16, 1898. ,,

Royal Microscopical Society. Journal, Nos. 104, 106, 1895; Nos. 120, 121, 1897; Nos. 122, 124, 1898. ,,

Royal Society. Philosophical Transactions, Vol. CLXXXVI., Parts 1 and 1A., 2 and 2B, 1895; Vol. CLXXXVII., Parts A and B, 1896; Vol. CLXXXVIII., Part A, 1896. List of Fellows, 30th November, 1896. ,,

Digitized by Google

NOTE.—Members are reminded that the next General Monthly Meeting will be held on Oct. 5, at 8 o'clock p.m. (the first Wednesday in the month).

DEC 20 1898
14237

Royal Society of New South Wales.

ABSTRACT OF PROCEEDINGS, SEPTEMBER 7, 1898.

The General Monthly Meeting of the Society was held at the Society's House, No. 5 Elizabeth street North, on Wednesday evening, September 7th, 1898.

The President, G. H. KNIBBS, F.R.A.S., in the Chair.

Twenty members and three visitors were present.

The minutes of the preceding meeting were read and confirmed.

The certificates of three candidates were read for the third time, of three for the second time, and of one for the first time.

The following gentlemen were duly elected ordinary members of the Society:—

Blunno, Michele, Licenziato in Scienze, (Roma), Government Viticultural Expert; Department of Agriculture, N.S.W.

Murray, Lee, M.C.E. *Melb.*, Civil Engineer; 65 Pitt-street.

Wade, Leslie A. B., Civil Engineer; Public Works Department.

THE FOLLOWING PAPERS WERE READ:—

1. "Key to Tribes and Genera of Melanospermeæ (Olive-green seaweeds)" by R. A. BASTOW.

This paper was taken as read.

2. "A study of the Dialects of New Caledonia," by Jules Bernier, Curator of the Musée Néo-Caledonienne. (Communicated by Charles Hedley, F.L.S.)

No less than twenty dialects are distinguished in New Caledonia, which are grouped into the following main divisions: the

Digitized by Google

Southern, inclusive of the Isle of Pines; the Central; the Northern; and those parts of the Loyalty Islands peopled by Melanesians. The first two are sharply separated from the latter by the absence of the article. The northern is characterised by a tendency to terminate in a consonant as shown by the place names, Belep, Hienghen, Wagap. A foreign aggressive Polynesian element can be detected intrusive upon the indigenous Melanesian. A marked feature in the New Caledonian language is its extreme simplicity, it is the most primitive Papuan speech. Even the roots are in a state of fluctuation and affect various forms. Any labial, or it may be any dental consonant, may be used by a native with a root vowel to express a particular word. The same word can be used as a noun, verb, or adjective, and the broad difference which elsewhere prevails between the parts of speech are here unknown. Monosyllabism prevails, and the roots have preserved a synthetic signification which seems a property of primitive people, but which is in more advanced languages obliterated by specialisation. Thus the native mind aggregates together such ideas as white, bright, eye, sun, day, light, and expresses them by forms of a root word "fire." A method occurs by which not only verbs but other parts of speech are conjugated. Enumeration is of the usual Papuan type, counting by one, one-one, one-two, one-three, five equal a hand (in reference to the digits) five-one, five-two, five-three, five-four, ten equal a head.

EXHIBITS.

1. An interesting collection of photographs from the Don Dorrigo and Brush districts, N. S. Wales, chiefly geological, were shewn by His Honor Judge DOCKER, M.A.

2. A new Eucalyptus oil was exhibited by Messrs. BAKER and SMITH of the Technological Museum, Sydney. On rectification this oil was found to contain a fraction boiling between 280° – 290° C., equalling 18 per cent. of the whole, and which consisted almost entirely of eudesmol, comparatively in a pure condition. The fraction wholly crystallised in less than one hour. This oil appears to be free from bodies, also of high boiling point, that

Digitized by Google

have previously been found to interfere with and to make the purification of this stearoptene difficult. Eudesmol has now been found to exist in the oils of six of the forty-five species of Eucalypts obtained. If eudesmol shall be found eventually to be of medicinal value, or useful for other purposes, we have in this oil a most prolific source of the material.

3. The latest type of Polariscope (Wright-Newton projecting polariscope) was exhibited by Dr. F. H. QUAIFE, M.A.

The following donations were laid upon the table and acknowledged :—

TRANSACTIONS, JOURNALS, REPORTS, &c.

(The Names of the Donors are in *Italics*).

BRISTOL—Bristol Naturalists' Society. Proceedings, N.S. Vol. VIII., Part ii., 1896-97. *The Society*

CAMBRIDGE—Cambridge Philosophical Society. Transactions, Vol. XVI., Part iv., 1898. ,,

Cambridge University Library. Annual Report (44th) of the Library Syndicate for year ending 31 Dec., 1897. *The University*

EDINBURGH—Royal Physical Society. Proceedings, Vol. XIII., Part iii., 1896-97. *The Society*

Royal Scottish Geographical Society. *Scottish Geographical Magazine*, Vol. XIV., Nos. 4 - 6, 1898. ,,

Scottish Microscopical Society. Proceedings, Vol. II., No. 2, Session 1896-97. ,,

FLORENCE—Società Italiana di Antropologia Etnologia &c. Archivio, Vol. XXVII., Fasc. 3, 1897. ,,

GEELONG—Gordon Technical College. *'The Wombat,'* Vol. III., Nos. 2, 3, 1998. *The College*

KEW—Royal Gardens. Hooker's Icones Plantarum, 4 Ser., Vol. VI., Part iii.. 1898. *The Director*

LIVERPOOL—Literary and Philosophical Society. Proceedings, Vol. LI., 1896-97. *The Society*

LONDON—Anthropological Institute of Great Britain and Ireland. Journal, Vol. XXVII., No. 2, 1897 ; No. 3, 1898. *The Institute*

British Museum (Natural History). Catalogue of the African Plants collected by Dr. Friedrich Welwitsch in 1853 - 61—Dicotyledons Part i. Catalogue of the Fossil Bryozoa in the Department of Geology—The Jurassic Bryozoa by J. W. Gregory, D.Sc. *The Museum*

Geological Society. Quarterly Journal, Vol. LIV., Part ii., No. 214, 1898. *The Society*

Institution of Mechanical Engineers. Proceedings, No. 4, 1896. *The Institution*

Digitized by Google

KEW—Royal Gardens. Hooker's Icones Plantarum, 4 Ser., Vol. VI., Part iii.. 1898 *The Director*

LIVERPOOL—Literary and Philosophical Society. Proceedings, Vol. LI., 1896-97. *The Society*

LONDON—Institution of Mechanical Engineers. Proceeding. Nos. 3, 4. 1897. *The Institution*

Iron and Steel Institute. Journal, Name Index, Vols. I. - L., 1869 - 1896. *The Institute*

Pharmaceutical Society of Great Britain. Journal, Fourth Series, Vol. VI., Nos. 1459, 1462 - 1469, 1898. *The Society*

Physical Society of London. Proceedings, Vol. XV., Part xii., No. 87, 1897. Science Abstracts, Vol. I., Parts i. - iv., 1898. "

Royal Agricultural Society of England. Journal, Third Series, Vol. IX , Part ii., No. 34, 1898. "

Royal Meteorological Society. Meteorological Record, Vol. XVII., No. 68, 1897. Quarterly Journal, Vol. XXIV., No. 107, 1898. "

Royal Society of Literature. Transactions, Second Series, Vol. XIX., Parts i. and ii., 1897. "

Royal United Service Institution. Journal, Vol. XLI., Nos. 230, 234 - 238, 1897; Vol. XLII., Nos. 239 - 241, 1898. Supplement to Lectures 1897. *The Institution*

Sanitary Institute of Great Britain. Journal, Vol. XVIII., Parts iii. and iv.; Vol. XIX., Part i., 1897-98. *The Institute*

Society of Arts. Journal, Vol. XLV., Nos. 2345 - 2347; Vol. XLVI., Nos. 2348 - 2362, 2364 - 2379, 1897-98. *The Society*

Zoological Society of London. Proceedings, Parts iii., iv., 1897; Part i., 1898. Transactions, Vol. XIV., Parts iv. - vi., 1897-98. "

MANCHESTER—Manchester Literary and Philosophical Society. Proceedings, Vols. II. - XV., Sessions 1860-61 - 1875-76. Memoirs, Third Series, Vols. I. - V., 1862 - 1876; Fourth Series, Vol. VI., 1892. Memoirs and Proceedings, Vol. XLII., Parts i., ii., 1897-98. "

Manchester Literary and Philosophical Society. Memoirs and Proceedings, Vol. XLII., Part iii., 1897-98. "

MARBURG—Gesellschaft zur Beförderung der gesammten Naturwissenschaften. Schriften, Band XIII., Abtheil 1, 1896. Sitzungsberichte, Jahrgang 1896. *The Society*

University—Inaugural Dissertations 1896-97 (85) *The University*

MELBOURNE—Australasian Institute of Mining Engineers. Proceedings, 14 January, 12 April, 1898. Transactions, Vol. V., 1898. *The Institute*

Australasian Journal of Pharmacy, Vol. XII., No. 144, 1897; Vol. XIII., Nos. 145 - 154, 1898. *The Editor*

Broken Hill Proprietary Co. Ld. Reports and Statements of Account for Half Years ending 30 Nov., 1897, and 31 May, 1898. *The Secretary*

Field Naturalists' Club of Victoria. *The Victorian Naturalist*, Vol. XIV., Nos. 1 - 12, Vol. XV., Nos. 1 - 6, 1897-8. *The Club*

Digitized by Google

NOTE.—Members are reminded that the next General Monthly Meeting will be held on Nov. 2, at 8 o'clock p.m. (the first Wednesday in the month).

DEC 20 1898
14,237

Royal Society of New South Wales.

ABSTRACT OF PROCEEDINGS, OCTOBER 5, 1898.

The General Monthly Meeting of the Society was held at the Society's House, No. 5 Elizabeth-street North, on Wednesday evening, October 5th, 1898.

The President, G. H. KNIBBS, F.R.A.S., in the Chair.

Thirty-six members and four visitors were present.

The minutes of the preceding meeting were read and confirmed.

The certificates of three candidates were read for the third time, of one for the second time, and of one for the first time.

The following gentlemen were duly elected ordinary members of the Society :—

Alexander, Frank Lee, Cement Maker ; Druitt-street.
Behrendt, Peter, Engineer ; O'Connell-street.
Kerry, Charles Henry, Photographer ; 310 George-street.

THE FOLLOWING PAPERS WERE READ :—

1. "On the Pinenes of the Oils of the genus Eucalyptus, Part 1," by HENRY G. SMITH, F.C.S., Technological Museum, Sydney.

This paper treated of the investigation of both dextrorotatory and lævorotatory pinenes found existing in large quantity in the oils obtained from two new species of Eucalypts growing in New South Wales. These two species belong to the group of Eucalypts known as the Stringybarks, and botanically both have many resemblances. The oils obtained from their leaves by steam distillation were found to consist principally of the terpene, pinene,

Digitized by Google

and although the oils resembled each other most markedly in many respects, it was found that while the pinene from *E. dextropinea* rotated the ray of light to the right, the pinene from the other species *(E. lævopinea)* rotated the ray to the left. The crude oil of *E. dextropinea* when redistilled gave 88 per cent. between 156° and 172° C., and on final rectification of the first fractions, this dextropinene was found to have the following characteristics: boiling point 156° C., specific gravity at $\frac{4}{4}°$ = 0·875, at $\frac{15}{15}°$ = 0·8629, and specific rotation at 18° C. of + 41·2°. The oil from *E. lævopinea* gave 88 per cent., distilling between 157° and 172° C. and this lævopinene on final rectification gave the following results: boiling point 157° C., specific gravity at $\frac{4}{4}°$ = 0·8755, at $\frac{15}{15}°$ = 0·8626, and specific rotation at 19° C. = −48·63. These results show that Eucalyptus oils contain pinenes having both right and left rotation. When equal volumes of these two pinenes were mixed it was found that the dextropinene had exactly neutralised an equivalent portion of the lævopinene as the remaining rotation was found to be almost identically the amount required theoretically. The dextropinene appears to be identical with that isolated from the oil of *Eucalyptus globulus* by Bourchardat and Tardy *(Comp. rend.* 1895, 120, 1417) and may be considered to be the physical isomeride of terebenthene obtained from French oil of turpentine. It also appears probable that the Eucalyptus dextropinene may eventually be found to be the isomeride of Eucalyptus lævopinene, and that these two pinenes always occur together in the natural state in various proportions, which governs the rotation of the particular oil. No phellandrene was detected in the oils of either species, and only a minute trace of eucalyptol. The hydrates, nitrosochlorides, monochloride etc., were prepared from both pinenes, and these were found to give identical results with those obtained from Australene and terebenthene, which terpenes they therefore chemically and physically resemble. The results indicate that these Eucalyptus pinenes (N.O. Myrtaceæ) are identical with the pinenes obtained from the pines (N.O. Coniferæ). It was stated by the author that it appears

Digitized by Google

for the lævopinene, the old name *Eucalyptene* remaining for the dextrorotatory form.

2. "Current Papers, No. 3," by H. C. Russell, B.A., C.M.G., F.R.S.

Since the previous paper on this subject was read one hundred and fifty-five papers have been collected, and a large percentage of them are of great interest. Seven were thrown over by Royal Mail Steamships between Ceylon and Aden, and with two exceptions were found on the coast of Africa, one on Farquhar Island and the other on the southern coast of Madagascar. It is noteworthy that these were all between the Equator and 24° South. No papers have been found in the sea between 24° and 30° South and thence southward all the papers have travelled to the east. A few papers found in the Indian Ocean north of the equator have also gone to the east. On the south coast they have followed the usual easterly course. In Tasman Sea several have followed unusual courses to north-north-east, one thrown over near Gabo was found on an island near the north of New Caledonia, another thrown over in the latitude of Gabo, but further east, was found on one of the New Hebrides islands. Of those thrown over by R.M.S. *Ormuz* when near Gabo, two are very remarkable, one three miles off Green Cape at 10·15 a.m. was found on the west coast of Zealand; at noon on the same day, twenty miles north of the position of the first one, a second bottle was thrown over, and it was found on the beach between Sydney and Newcastle.

EXHIBITS.

1. Prof. Liversidge, M.A., LL.D., F.R.S., exhibited specimens of the blue pigment which he had separated from *Heliopora cærulea*, brought by Prof. David from Funafuti, together with solutions of it and of indigo for comparison.

2. Prof. T. P. Anderson Stuart, M.D., exhibited a specimen of artificial silk, and showed the acetylene light.

3. Mr. Russell exhibited Dine's Portable Anemometer.

4. Prof. David exhibited specimens of cores of coral rock from the Funafuti Bore from depths of eight hundred and fifty to nine

Digitized by Google

brought by Prof. David from Funafuti, together with solutions of it and of indigo for comparison.

2. Prof. T. P. Anderson Stuart, M.D., exhibited a specimen of artificial silk, and showed the acetylene light.

3. Mr. Russell exhibited Dine's Portable Anemometer.

4. Prof. David exhibited specimens of cores of coral rock from the Funafuti Bore from depths of eight hundred and fifty to nine hundred and eighty-seven feet, the latter being the greatest depth attained by the boring up to the time when Mr. Gerald H. Halligan left the atoll on September 6th. The rock is harder than that previously encountered, but is easier for boring, as it does not need to be supported by lining pipes to prevent caving. Mr. Halligan exhibited specimens of the material dredged by Mr. A. E. Finckh and himself from the seaward slope of the atoll, from between depths of thirty and two hundred fathoms. The apparatus used consisted of a heavy steel chisel and hempen tangles, and a strong conical steel bucket with sharp cutting edge. The results were very satisfactory, a considerable amount of new and useful material having been obtained. Mr. Halligan also exhibited samples of the *Halimeda* sand and coral heads obtained by him when in charge of the hydraulic drill belonging to the Works Department of New South Wales, and placed on H.M.S. *Porpoise* for the purpose of boring the bottom of the Funafuti lagoon. Professor David stated that the time allowed by the Admiralty for the boring was one week, and in this short space of time two bores had been put down to depths respectively of two hundred and forty-five and two hundred and fourteen feet below the surface of the lagoon, the depth of water at the sites of both bores being one hundred and one feet. The *Halimeda* sand proved to be eighty feet thick, and under that in each bore coral heads, apparently *in situ*, had been penetrated. The rate of boring in the bottom of the lagoon had averaged about forty-five feet per day, a highly satisfactory result. The evidence obtained would probably be of great value, as bearing on the subject of Darwin's theory as to the formation of atolls by subsidence.

Digitized by Google

ABSTRACT OF PROCEEDINGS, OCTOBER 5, 1898.

The General Monthly Meeting of the Society was held at the Society's House, No. 5 Elizabeth-street North, on Wednesday evening, October 5th, 1898.

The President, G. H. KNIBBS, F.R.A.S., in the Chair.

Thirty-six members and four visitors were present.

The minutes of the preceding meeting were read and confirmed.

The certificates of three candidates were read for the third time, of one for the second time, and of one for the first time.

The following gentlemen were duly elected ordinary members of the Society :—

Alexander, Frank Lee, Cement Maker ; Druitt-street.
Behrendt, Peter, Engineer ; O'Connell-street.
Kerry, Charles Henry, Photographer ; 310 George-street.

THE FOLLOWING PAPERS WERE READ :—

1. "On the Pinenes of the Oils of the genus Eucalyptus, Part 1," by HENRY G. SMITH, F.C.S., Technological Museum, Sydney.

This paper treated of the investigation of both dextrorotatory and lævorotatory pinenes found existing in large quantity in the oils obtained from two new species of Eucalypts growing in New South Wales. These two species belong to the group of Eucalypts known as the Stringybarks, and botanically both have many resemblances. The oils obtained from their leaves by steam distillation were found to consist principally of the terpene, pinene, and although the oils resembled each other most markedly in many respects, it was found that while the pinene from *E. dextropinea* rotated the ray of light to the right, the pinene from the other species *(E. lævopinea)* rotated the ray to the left. The crude oil of *E. dextropinea* when redistilled gave 88 per cent. between 156° and 172° C., and on final rectification of the first fractions, this dextropinene was found to have the following characteristics: boiling point 156° C., specific gravity at $\frac{4}{4}$° = 0·875,

Digitized by Google

EASTON, PA.—American Chemical Society. Journal, Vol. XIX., Nos. 11, 12, 1897; Vol. XX., Nos. 1 – 5, 1898. . *The Society*

EDINBURGH—Highland and Agricultural Society of Scotland. Transactions, 5 Ser., Vol. X., 1898. „

Royal Scottish Geographical Society. *Scottish Geographical Magazine*, Vol. XIV., No. 7, 1898. „

Royal Society of Edinburgh. Proceedings, Vol. XXI., Sessions 1895-97. Transactions, Vol. XXXVIII., Parts iii., iv., Session 1895-96; Vol. XXXIX., Part i., Session 1896-97. „

University. Calendar, 1898-99. *The University*

FORT MONROE, Va.—U. S. Artillery School. Journal of the U.S. Artillery, Vol. IX., Nos. 2, 3, 1898. *The School*

GEELONG—Gordon Technical College. *The Wombat*, Vol. III., No. 4, 1898. *The College*

GENEVA—Institut National Genevois. Bulletin, Tome XXXIV., 1897. *The Institute*

GLASGOW—University. Calendar 1898-9. *The University*

JAMAICA—Institute of Jamaica. Journal, Vol. II., Nos. 2 and 5, 1895-97. *The Institute*

LAUSANNE—Société Vaudoise des Sciences Naturelles. Bulletin, 4 Ser., Vol. XXXIII., Nos. 125, 126, 1897. *The Society*

LINCOLN—U.S. Agricultural Experimental Station. Bulletin, Vol. X., Nos. 50 - 54, 1897-98. *The Station*

LONDON—Anthropological Institute of Great Britain and Ireland. Journal, Vol. XXVII., No. 4, 1898. *The Institute*

Institution of Civil Engineers. Minutes of Proceedings, Vols. CXXXI., CXXXII., 1897-98. *The Institution*

Physical Society of London. Proceedings, Vol. XVI., Part i., 1898. List of Officers and Fellows, 1898. Science Abstracts, Vol. I., Parts vi., vii., 1898. *The Society*

Royal Astronomical Society. Monthly Notices, Vol. LVIII., No. 8, 1898. „

Royal Geographical Society. *Geographical Journal*, Vol. XII., Nos. 1, 2, 1898. „

Royal Microscopical Society. Journal, Part iv., No. 125, 1898. „

Royal Society of Literature. Report and List of Fellows 1898. Transactions, Second Series, Vol. XIX., Parts iii., and iv., 1898. „

Sanitary Institute. Journal, Vol. XIX., Part ii., 1898. *The Institute*

Society of Arts. Journal, Vol. XLVI., Nos. 2380 - 2388. *The Society*

LUBECK — Geographische Gesellschaft und Naturhistorische Museums. Mitteilungen, Zweite Reihe, Heft. 10, 11, 1896. *The Museum*

MANCHESTER—Conchological Society of Great Britain and Ireland. Journal of Conchology, Vol. IX., Nos. 1 – 3, 1898. *The Society*

Manchester Geological Society. Transactions, Vol. XXV., Parts 12 – 16, 1897-98. „

MARSEILLES—Faculté des Sciences de Marseille. Annales, Tome VIII., Fasc. 5 – 10, 1898. *The Faculty*

Digitized by Google

ABSTRACT OF PROCEEDINGS, NOVEMBER 2, 1898.

The General Monthly Meeting of the Society was held at the Society's House, No. 5 Elizabeth-street North, on Wednesday evening, November 2nd, 1898.

The President, G. H. KNIBBS, F.R.A.S., in the Chair.

Twenty-six members and one visitor were present.

The minutes of the preceding meeting were read and confirmed.

The certificate of one candidate was read for the third time, of one for the second time, and of one for the first time.

The following gentleman was duly elected an ordinary member of the Society:—

Thow, Sydney, Engineer; 24 Bond-street.

The members are informed that the library of the New South Wales Branch of the British Medical Association (121 Bathurst-street) is available for their use, the Association and this Society having entered into a reciprocal arrangement. This arrangement does not extend to the lending out of books.

THE FOLLOWING PAPERS WERE READ:—

1. "Soaring Machines," by Mr. LAWRENCE HARGRAVE.

The paper describes some recent experiments with soaring machines and gives as a reason for rejecting the form previously made, that its nature was such that however long or heavy the ends of the rod were, they could only retard for a longer or shorter period of time the tipping up or down of the machine. The weight is now hung underneath the propeller, like the car of a balloon or parachute, the angle of incidence being regulated by gravity alone. Some previous experimenters with soaring machines were mentioned who have, as a rule, been greatly discredited. A diagram showed the condition of the air in the neighbourhood of a soaring curve with the names of the various parts.

2. "Native Vocabulary of Miscellaneous New South Wales Objects etc.," by Mr. Surveyor LARMER. (Communicated by Professor T. P. Anderson Stuart, M.D., by permission of the Honourable the Secretary for Lands).

Digitized by Google

EXHIBITS.

1. Mr. RUSSELL exhibited a diagram shewing for the past eleven years a progressive variation in the *level*, *nadir* and *azimuth* of the Transit instrument, Sydney Observatory. These diagrams shew an annual variation as well as a variation due to heavy rains. The instrument is of the very best quality, cannot produce these changes within itself, and stands upon a very massive pier which was built forty years ago on the solid rock. It was shewn that the progressive changes would be accounted for if the sandstone is dipping to south ten degrees west, and instances were given shewing that any heavy fall of rain caused a sudden change in the instrument, coincident with what would happen if the weight of the rain bent down the sandstone to the west of the Observatory. Other Observatories had noted similar changes, notably that of the Cape of Good Hope, where it was found that the instrument was affected by the accumulation of water in an adjacent swamp.

2. Professor THRELFALL exhibited a large number of materials required in well-equipped physical laboratories which recent industrial advances have made commercially available.

The PRESIDENT then addressed Professor Threlfall in the following words:—"For the interesting exhibits by Professor Threlfall the Society is greatly indebted. As most of you are aware this meeting of the Royal Society is probably the last at which we shall have the pleasure of our esteemed friend's presence, inasmuch as he proposes leaving for England during the current month. We cannot let this opportunity pass, therefore, without publicly expressing our very great regret at losing Professor Threlfall as a member of our Society, and at losing his services in our University and community. On behalf of our Society, I may venture to say that we very keenly appreciate his scientific labours amongst us.

"Perhaps not the least conspicuous and important feature among these is the creation of the splendidly equipped physical laboratory at the University, and his work and influence therein. These are monuments of his energy which will live on in the life

Digitized by Google

of our community, and are instruments of scientific culture which will leave their mark on the future of our people.

"More directly as concerns our Society Prof. Threlfall's capable services both in the deliberations of its Council and in the direction of its affairs during his office as President challenge our gratitude. His interesting and incisive discussions at our meetings and the readiness with which he always responded to every appeal for assistance in the more important movements of our Society, will long be remembered by those who take any interest in its affairs.

"I may be pardoned for making a personal reference to my own indebtedness to Prof. Threlfall. I wish to say that in so far as I have been able to follow—a very long way off—in his footsteps as a student of physics, it has been largely due to the stimulus of his personal influence and the infection of his enthusiasm for that subject of which he is so able an exponent.

"Professor Threlfall, on behalf of the Royal Society, I offer you our very best wishes for your future and the future of those near and dear to you, and I beg to assure you that we part with you with profound regret and with a keen sense of how much as a Society we owe to you and to your ardent affection for Science."

Professor THRELFALL replied, "Mr. President and Gentlemen, I thank you very heartily for the kind words which you, Sir, have spoken and to which the Society has so graciously responded and endorsed. If I may accept Mr. Knibbs' assurance as to the effect of my feeble strivings on him personally as his reasoned opinion, and not merely as an expression of his kindliness towards me, then I can say that if I had done nothing else, my time has not been wasted.

"I should like to take this opportunity of referring to the great assistance and encouragement which I have received from the Royal Society ever since I came to the Colony; I should like to place on record my sense of the stimulus which I have received from the Society, and of the profit I have had in attending its meetings and discussing the things in which I am interested. I

Digitized by Google

should like to say that I consider the Society holds a very important place in the community, both on account of the work which it publishes, and on account of the ideal of scientific work which it holds up. Personally I am immensely indebted to the Society for the encouragment it has always given me and also for the great use I have had of its fine library, without which it would have been impossible at one time for me to have done any work at all. I shall always look back upon my connection with the Society with the warmest gratitude and pleasure, and consider that the fellowship of the Society is one of which any man might be proud. Let me conclude by again thanking you all for your kindness towards me."

The following donations were laid upon the table and acknowledged :—

TRANSACTIONS, JOURNALS, REPORTS, &c.

(The Names of the Donors are in *Italics*.)

AMSTERDAM—Koninklijk Zoologisch Genootschap. "Natura Artis Magistra," 1838–1898. *The Society*

Nederlandsche Maatschappij ter bevordering van Nijverheid. Tijdschrift, Nieuwe Reeks, Deel I., Nov., Dec., 1897; Deel II., Jan.–Mar., May–Oct., 1898. *The Association*

Royal Academy of Sciences. Verhandelingen, Afd. Natuurkunde, 1 Sectie, Deel VI., Nos. 1–5; 2 Sectie, Deel VI., Nos. 1, 2. Zittingsverslagen, Afd. Natuurkunde, Deel VI., 1897-8. Jaarboek 1897. *The Academy*

BALTIMORE—Johns Hopkins University. Zum hochalemannischen Konsonantismus der althochdeutschen Zeit. von Dr. Friedrich Wilkens, 1891. *The University*

BARCELONA—Real Academia de Ciencias y Artes. Boletin, Vol. I., No. 15, 1897. *The Academy*

BERLIN — Centralbureau der Internationalen Erdmessung. Bericht über den stand der Erforschung der breitenvariation im December 1897 von Th. Albrecht. *The Bureau*

Gesellschaft für Erdkunde. Verhandlungen, Band XXIV., Nos. 8–10, 1897; Band XXV., Nos. 1–4, 1898. Zeitschrift, Band XXXII., Nos. 5, 6, 1897; Band XXXIII., Nos. 1, 2, 1898. *The Society*

Königlich preussische Akademie der Wissenschaften. Sitzungsberichte, Nos. 1 - 39, 1898. *The Academy*

Königlich preussische Meteorologische Instituts. Bericht über die Thätigkeit im Jahre 1897. Ergebnisse der Beobachtungen an den Stationen II. und III. Ordnung Heft 2, 1897. Ergebnisse der Gewitter-Beobachtungen in den Jahren 1895 und 1896. *The Institute*

Digitized by Google

BIRMINGHAM—Birmingham and Midland Institute. Programme for Session 1898-99. *The Institute*

BOSTON, Mass.—American Academy of Arts and Sciences. Proceedings, Vol. XXXIII., Nos. 13 - 27, 1898. *The Academy*

Boston Society of Natural History. Proceedings, Vol. XXVIII., Nos. 8 - 12, 1898. *The Society*

BONN—Naturhistorischer Verein der preussischen Rheinlande, Westfalens und des Reg.-Bezirks Osnabrück. Verhandlungen, Jahrgang LIV., Heft 2, 1897. ,,

Niederrheinische Gesellschaft für Natur-und Heilkunde. Sitzungsberichte, Hälfte 2, 1897. ,,

BREMEN — Naturwissenschaftlicher Verein. Abhandlungen, Band XIV., Heft 3, 1898; Band XV., Heft 2, 1897. ,,

BRISBANE—Department of Agriculture. Contributions to the Flora of Queensland and New Guinea, Extract from *The Queensland Agricultural Journal*, Vol. III., Parts iii. - v., 1898. *The Department*

Geological Survey. Bulletin, Nos. 8 - 10, 1898. *The Survey*

BRUSSELS—Académie Royale des Sciences, des Lettres et des Beaux-Arts. Annuaire 1896, 1897. Bulletin, 3 Ser., Année 65 - 67, Tome XXX. - XXXIII., 1895 - 1897. Notices Biographiques and Bibliographiques, 4th Edition, 1896. Règlements et Documents Concernant les Trois Classes 1896. *The Academy*

Observatoire Royal de Bruxelles. Annales Astronomiques, N.S. Tome VII., 1896. Annales Météorologiques, N.S. Tome III., IV., 1895. Annuaire, Année 56 - 64, 1889 - 1897. Bibliographie Générale de l'Astronomie par J. C. Houseau et A. Lancaster, Tome I., Seconde Partie 1889. *The Observatory*

Société Royale Malacologique de Belgique. Annales, Tome XXVIII. - XXX., 1893-95; Tome XXXI., Fasc. 1, 1896. Procès-Verbaux des Sèances, Tome XXIV., 1895; Tome XXV., 1896; Tome XXVI., 1897; Tome XXVII., 1898 (pp. 1 - 72). *The Society*

BUENOS AIRES—Museo Nacional. Anales, Tome V., (Ser. 2, Tome II.) 1896-97. Memoria, 1894, 1895, 1896. *The Museum*

Instituto Geográfico Argentino. Boletin, Tomo XVIII., Nos. 7 - 12, 1897. *The Institute*

BUFFALO—Buffalo Society of Natural Sciences. Bulletin, Vol. V., No. 5, 1897; Vol. VI., No. 1, 1898. *The Society*

CALCUTTA—Geological Survey of India. General Report on the work carried on by the Geological Survey of India for the period from 1st Jan. 1897 to the 1st April 1898. *The Survey*

CAMBRIDGE—Cambridge Public Free Library. Annual Report (43rd) of 1897 - 1898. *The Library*

CAMBRIDGE (Mass.)—Museum of Comparative Zoölogy at Harvard College. Bulletin, Vol. XXVIII., Nos. 4, 5; Vol. XXXI., No. 7; Vol. XXXII., Nos. 3 - 8, 1898. *The Museum*

CASSELL—Vereins für Naturkunde zu Kassel. Abhandlungen und Bericht, Vol. XLII., 1896-97. *The Society*

Digitized by Google

MELBOURNE—Public Library, Museums, and National Gallery of Victoria. Report of the Trustees for 1897. *The Trustees*

Royal Geographical Society of Australasia (Victoria). Transactions, Vol. XV. *The Society*

Royal Society of Victoria. Proceedings, (New Series) Vol. X., Part ii; Vol. XI., Part i., 1898. ,,

University. Calendar 1897, 1899. *The University*

MERIDEN, Conn.—Meriden Scientific Association. Transactions, Vol. VIII., 1897-98. *The Association*

METZ—Vereins für Erdkunde. Jahresbericht, XIX., 1896-97. *The Society*

MILAN—Società Italiana di Scienze Naturali. Atti, Vol. XXXVII., Fasc. 2, 1898. ,,

MODENA—Regia Accademia di Scienze, Lettere ed Arti Memorie, Serie 2, Vol. XII., Partie i., 1896. *The Academy*

MONTPELLIER—Académie des Sciences et Lettres de Montpellier. Mémoires de la Section des Sciences, Série 2, Tome II., Nos. 2 – 4, 1895-6. ,,

MULHOUSE—Société Industrielle de Mulhouse. Bulletin, Vol. LXVII., Sept. – Dec. 1897; Vol. LXVIII., Jan. – Mar. 1898. *The Society*

NANTES—Société des Sciences Naturelles de l'Ouest de la France. Bulletin, Tome VI., Trimestre 4, 1896; Tome VII., Trimestre 1 – 3, 1897. ,,

NAPLES—Società Reale di Napoli. Rendiconto dell' Accademia delle Scienze Fisiche e Matematiche Ser. 3, Vol. III., Fasc. 8 – 12, 1897; Vol. IV., Fasc. 1, 2, 1898. ,,

NEWCASTLE-UPON-TYNE—Natural History Society of Northumberland, Durham and Newcastle-upon-Tyne. Natural History Transactions, Vol. XIII., Part ii., 1898. ,,

North of England Institute of Mining and Mechanical Engineers. Transactions, Vol. XLVI., Parts iv. – vi., and Annual Report 1896-7; Vol. XLVII., Parts i. – v., 1897-98. An account of the Strata of Northumberland and Durham as proved by Borings and Sinkings U – Z, 1897. *The Institute*

NEW YORK—American Geographical Society. Bulletin, Vol. XXIX., Nos. 3, 4, 1897; Vol. XXX., Nos. 1, 2, 3, 1898. *The Society*

American Museum of Natural History. Bulletin, Vol. IX., 1897. *The Museum*

New York Academy of Sciences. Annals, Vol. IX., Nos. 6 – 12, 1897. *The Academy*

New York Microscopical Society. Journal, Vol. XIII., No. 4, 1897; Vol. XIV., No. 1, 1898. *The Society*

School of Mines, Columbia College. The School of Mines Quarterly, Vol. XVIII., No. 4, 1897; Vol. XIX., Nos. 1, 2, 3, 1898. *The School*

OXFORD—Radcliffe Library. Catalogue of Books added during the year 1897. *The Trustees*

Digitized by Google

ABSTRACT OF PROCEEDINGS, DECEMBER 7, 1898.

The General Monthly Meeting of the Society was held at the Society's House, No. 5 Elizabeth-street North, on Wednesday evening, December 7th, 1898.

The President, G. H. KNIBBS, F.R.A.S., in the Chair.

Thirty members and one visitor were present.

The minutes of the preceding meeting were read and confirmed.

The certificate of one candidate was read for the third time, of one for the second time, and of one for the first time.

The following gentleman was duly elected an ordinary member of the Society:—

Burfitt, Walter Fitzmaurice, B.A., B.Sc.; Glebe Point.

Messrs. DAVID FELL and H. A. LENEHAN, were appointed Auditors for the current year.

THE FOLLOWING PAPERS WERE READ:—

1. "The Group Divisions and Initiation Ceremonies of the Barkunjee Tribes" by R. H. MATHEWS, L.S.

Mr. R. H. Mathews read a short article on the Group Divisions and Initiation Ceremonies of the Barkunjees, a native tribe in the western portion of New South Wales. He pointed out that all the men and women in the community are divided into two distinct groups, designated Keelparra and Muckwarra respectively, the individuals of one group intermarrying with those of the other. The inaugural ceremonies common among these tribes was next briefly referred to. On the boys approaching puberty they are taken away from the maternal control, and are kept under rigorous treatment in the bush with the chiefs and wise men of their tribe, for several weeks. During this period they are subjected to the extraction of a front tooth, cutting off the hair, and the ancient rite of circumcision.

2. "Native Silver accompanying Matte and Artificial Galena," by Professor LIVERSIDGE, M.A., LL.D., F.R.S.

Digitized by Google

Prof. Liversidge, M.A., LL.D., F.R.S., exhibited some specimens forwarded to him by Mr. Edgar Hall, F.C.S., of Tenterfield, which Mr. Hall had obtained from between two courses of brickwork in the arch over the vault of an old reverberatory furnace, the upper course had been raised bodily, but remained intact, and the space between became filled to a thickness of about four inches with a layer of clean matte; the metallic silver occurs on the surfaces in the cracks and crevices of the matte and bricks.

Mr. Hall also states that the matte assays about 120 ozs. of silver per ton, 67% lead and 5% copper, whereas no matte ever tapped out of the furnace in the usual way assayed less than 350 ozs. silver, 20% copper, and only about 25% lead; and probably the average of all the matte made in the furnace would be 25% copper 25% lead, 400 ozs. silver and 1 oz. of gold per ton.

Mr. Hall remarks "now it seems to me that this lead matte (an artificial galena?) must have separated out from the liquid matte and passed through the porous brick arch as a compound of definite composition, leaving the copper and silver behind."

Prof. Liversidge stated that the galena breaks with a granular fracture, and as might be expected, it is harder than usual. The silver occurs in thin films not in wires or globules, it does not appear to have been fused, but looks as if it had been reduced from silver sulphide.[1] The silver sulphide had probably liquated out from the matte, as it is very much more fusible.

3. "The Blue Pigment of Corals," by Professor Liversidge, M.A., LL.D., F.R.S.

The coral examined was *Heliopora cœrulea*, obtained by Prof. David from Funafuti Atoll when conducting the Coral Reef Exploration in 1897. He states that it is very abundant there in places. The specimens were of a dull light slate-blue colour externally and a little darker internally.[2] The pigment has not yet been obtained in a pure condition, as the quantity at my

[1] See A. Liversidge, "On the Formation of Moss Gold and Silver"—Roy. Soc. N.S.W., 1876; Chem. News, 35, 1877.

[2] See Mosely's paper in the Challenger Report, Zoology II., p. 109.

Digitized by Google

disposal was very small. Neither has it yet been obtained in a crystallized condition; its best solvent appears to be glacial acetic acid, to which it imparts a rich blue colour. It appears to be quite distinct from indigo, also from the blue pigment of lobster shell and other blue substances, the colour of the Emu egg shell seems to be somewhat similar. Its ash contains a good deal of iron, phosphoric oxide, lime and some magnesia. Rather more than 1% of the crude pigment was obtained from a freshly collected specimen, an old waterworn dead specimen yielded only ·26% of pigment. It does not readily lend itself to dyeing either silk, wool, or cotton. On extracting it in a percolator with glacial acetic acid or with absolute alcohol it after a time changes to a green colour. Dilute solutions of indigo in acetic acid or of sulphindigolic acid fade much more quickly than solutions of the coral blue of equal depths of colour.

EXHIBITS.

1. Mr. HAMLET exhibited a small spectroscope by Reichert. It consisted of a system of direct vision prisms, a reflecting prism by means of which a separate spectrum may be observed at the same time; a bright-line micrometer scale enables the observer to locate at once the right position of absorption bands or the usual lines emitted by incandescent bodies. He also shewed a convenient Abbé refractometer by Reichert of Vienna, for ascertaining the refractive indices of oils and other liquid substances. The principle of construction of the instrument is based on total reflection, which takes place at a thin film of liquid enclosed between two prisms of high refractive power. To use the instrument, one of the prisms is removed and the exposed surface of the other brought into the horizontal plane. A drop of liquid is then placed on it and covered by the second prism. An adjustment is made to the boundary between light and dark. Dispersion is removed by a compensator, and the index of refraction is read off directly from the scale.

2. Prof. DAVID exhibited, on behalf of Mr. E. C. Andrews, B.A., specimens collected by the latter from the raised coral reefs of the

Digitized by Google

Fiji Group. Mr. Andrews had lately made cursory geological examinations of the raised reefs of Fiji, on behalf of Professor A. Agassiz of Harvard College, Mass., U.S.A., and found that the raised reefs extended up to a height of over 1000 feet above sea-level. There was evidence that some of the volcanic rocks were newer than the raised reefs, while other volcanic rocks were older. Many of the Fiji raised reefs were distinctly terraced, as the result of pauses in the process of elevation. Prof. David interpreted the bearing of Mr. Andrews' observations on the Funafuti boring, and indicated the different types of reef which might be formed respectively during rapid elevation and rapid subsidence, and rapid subsidence becoming progressively slower until stable equilibrium is reached. He also exhibited a sample of the so-called "Edible Earth" of Fiji, which natives of that group are in the habit of eating. This is a very soft and highly decomposed pinkish-grey volcanic rock, of a basic type, with traces of chalcedonic lumps. The sample was forwarded by the Hon. Dr. B. G. Corney, Chief Medical Officer, Suva, Fiji.

3. His Honor Judge DOCKER, M.A., exhibited a series of stereoscopic views of a geological character, photographed by himself, they comprised groups of trachyte rocks called 'the Gins,' from the Nandewarr Range near Narrabri, also volcanic cores from the Warrumbungle Mountains.

The following donations were laid upon the table and acknowledged:—

TRANSACTIONS, JOURNALS, REPORTS, &c.

(The Names of the Donors are in *Italics*)

BATAVIA—Koninklijke Natuurkundige Vereeniging in Nederl. Indië. Natuurkundig Tijdschrift voor Nederlandsch-Indië, Deel LVII.; Tiende Serie, Deel I., 1898. Boekwerken, 1897. *The Society*

BERGEN—Bergens Museums. Aarbog for 1897. An account of the Crustacea of Norway, Parts IX., X., 1898. *The Museum*

BERKELEY, Cal.—University of California. Bulletin—Agricultural Experiment Station—Nos. 116–119, 1897. Register 1896-97. Annual Report of the Secretary to the Board of Regents for the year ending 30 June, 1896. The University Chronicle, Vol. I., No. 1, 1898. Resistant Vines by Arthur P. Hayne, PH.B. The Beet Sugar In-

Digitized by Google

BERKELEY—*continued.*
dustry and its development in California by E. W. Hilgard. Address of Regent J. B. Reinstein, 15 Jan. 1898. Report of Committee on Ways and Means, 20 May, 1896. Report and Addendum submitted by the Academic Council to the Joint Committee of the Board of Regents on the subject of Instruction in Astronomy in the University, June 6, 11, 1895. Comparative Chart of Attendance and Income 1887 – 1896. Reference list to the published writings of John Muir by Cornelius B. Bradley, 1897. *The University*

CHRISTIANIA—Videnskabs-Selskabet. Forhandlinger, 1891, 1892, 1895, 1896. Skrifter, 1895, 1896. *The Society*

CINCINNATI—Cincinnati Society of Natural History. Journal, Vol. XIX., No. 4, 1898. ,,

COPENHAGEN—Société Royale des Antiquaires du Nord. Mémoires, Nouvelle Série, 1897. Tillœg til Aarboger for nordisk Oldkyndighed og Historie, Aargang 1896-97. .,

CORDOBA—Academia Nacional de Ciencias. Boletin, Tome XV., Entrega 2 – 4, 1897. *The Academy*

CRACOW—Académie des Sciences. Bulletin International, Nos. 2 – 7, 1898. ,,

DRESDEN—Königl. Mineralogisch-Geologisches und Prä-Historisches Museum. Mitteilungen, Heft 13, 1897. *The Museum*

K. Sächs. Statistische Bureau. Zeitschrift, Jahrgang XLIII., Heft 3, 4 and Supplement 1897; Jahrgang XLIV., Heft 1, 2 and Supplement, 1898. *The Bureau*

DUBLIN—Royal Irish Academy. Transactions, Vol. XXXI., Parts i. – vi., 1896-97. *The Academy*

EASTON Pa.—American Chemical Society. Journal, Vol. XX., Nos. 6 – 10, 1898. *The Society*

EDINBURGH—Royal Scottish Geographical Society. *The Scottish Geographical Magazine*, Vol. XIV., Nos. 8, 9, 1898. ,,

FLORENCE—Società Italiana di Antropologia, Etnologia &c. Archivio, Vol. XXVIII., Fasc 1, 1898. ,,

FRANKFURT A/M—Senckenbergische Naturforschende Gesellschaft. Abhandlungen, Band XXI., Heft 1; Band XXIV., Heft 1, 1897. ,,

FREIBURG (Baden)—Naturforschende Gesellschaft. Berichte, Band X., Heft 1 – 3, 1897-8. ,,

GLASGOW—Philosophical Society of Glasgow. Proceedings, Vol. XXIX., 1897-98. ,,

GÖRLITZ—Naturforschende Gesellschaft. Abhandlungen, Band XXII., 1898. ,,

GOTHEMBURG—Kungl. Vetenskaps-och Vitterhets-Samhälles. Handlingar, Ser. 4, Tome I., 1898. ,,

GÖTTINGEN—Königliche Gesellschaft der Wissenschaften. Nachrichten, Geschäftliche Mittheilungen Heft 1, 1898. Mathematisch-physikalische Klasse Heft 1 – 3, 1898. ,,

Digitized by Google

HALLE—Kaiserliche Leopoldino-Carolinische Deutsche Akademie der Naturforscher. Abhandlungen (Nova Acta) Band LXVIII., LXIX., 1897, 1898. Katalog der Bibliothek. Lieferung 8 (Band II., 5), 1897. Leopoldina, Heft XXXIII., 1897. *The Academy*

HAMBURG—Deutsche Seewarte. Archiv, Jahrgang XX., 1897. Resultate Meteorologischer Beobachtungen von Deutschen und Hollandischen Schiffen für Eingradfelder des Nordatlantischen Ozeans No. XVI., 1898. *The Observatory*

Geographische Gesellschaft in Hamburg. Mittheilungen, Band XIV., 1898. *The Society*

HAARLEM—Koloniaal Museum te Haarlem. Bulletin, May–July 1898. Extra Bulletin 1897 viz.: Nuttige Indische Planten door Dr. M. Greshoff, Aflevering 4. *The Museum*

Musée Teyler. Archives, Ser. 2, Vol. V., Part iv.; Vol. VI., Part i., 1898. "

Société Hollandaise des Sciences. Archives Néerlandaises des Sciences Exactes et Naturelles, Ser. II., Tome I., Liv. 2–5, 1897-8; Tome II., Liv. 1., 1898. *The Society*

HELSINGFORS—Société des Sciences de Findlande. Öfversigt, Förhandlingar, Vol. XXXIX., 1896-97. Observations publiées par l'Institut Météorologique Central, Vol. XV., Liv. 1, 1896. Résumé des années 1881–1890. Acta, Tomus XXII., XXIII., 1897. "

HOBART—Department of Mines. The Progress of the Mineral Industry of Tasmania for the Quarter ending 30 Sept., 1898. *The Department*

Royal Society of Tasmania. Proceedings, Session 1897. The Iron Deposits of Tasmania by W. C. Dauncey, C.E., M.E. *The Society*

JENA—Medicinisch-Naturwissenschaftliche Gesellschaft. Jenaische Zeitschrift für Naturwissenschaft, Band XXXI., (N.F. Bd. XXIV.) Heft 2–4; Band XXXII., (N.F. Bd. XXV.) Heft 1, 2, 1897-8. "

KIEFF—Société des Naturalistes. Mémoires, Tome XIV., Liv. 2; Tome XV., Liv. 1, 2, 1896-8. "

KÖNIGSBERG—Physikalisch-ökonomische Gesellschaft. Schriften, Jahrgang XXXVIII., 1897. "

LA PLATA—Museo de la Plata. Revista, Tome VIII., 1898. *The Museum*

LAUSANNE—Société Vaudoise des Sciences Naturelles. Bulletin, 4 Ser., Vol. XXXIV., No. 127, 1898. *The Society*

LEIPZIG—Königl. Sächsische Gesellschaft der Wissenschaften. Berichte, Heft 5, 6, 1897. "

Vereins für Erdkunde. Mitteilungen, 1897. "

LIÉGE—Société Géologique de Belgique. Annales, Tome XXII., Liv. 3, 1894-97; Tome XXIII., Liv. 3, 1895-97; Tome XXIV., Liv. 2, Tome XXV., Liv. 1, 1897-98. "

Scciété Royale des Sciences. Mémoires, Série 2, Tome XX., 1898. "

Digitized by Google

LONDON—British Museum (Natural History). Catalogue of Welwitsch's African Plants 1853 - 61—Dicotyledons, Part ii., by W. P. Hiern, M.A., F.L.S., 1898. List of the Types and Figured Specimens of Fossil Cephalopoda in the Museum, 1898. *The Museum*

Geological Society. Quarterly Journal, Vol. LIV., Part iii., No. 215, 1898. *The Society*

Institution of Civil Engineers. Minutes of Proceedings, Vol. CXXXIII., Part iii., Session 1897-98. Report of Committee on the Thermal Efficiency of Steam-Engines 1898. *The Institution*

Institution of Naval Architects. Transactions, Vol. XL., 1898. ,,

Iron and Steel Institute. Journal, Vol. LIII., No. 1, 1898. Rules and List of Members, 1898. *The Institute*

Linnean Society. Journal, Botany, Vol. XXXIII., Nos. 231 - 233. Zoology, Vol. XXVI., Nos. 169 - 171, 1898. *The Society*

Pharmaceutical Society of Great Britain. Pharmaceutical Journal, 4 Ser., Vol. VII., Nos. 1470 - 1478, 1898. ,,

Physical Society of London. Proceedings, Vol. XVI., Part ii., 1898. Science Abstracts, Vol. I., Parts viii. - x., 1898. ,,

Quekett Microscopical Club. Journal, Ser. II., Vol. VII., No. 42, 1898. *The Club*

Royal Agricultural Society of England. Journal, Third Series, Vol. IX., Part iii., No. 35, 1898. *The Society*

Royal College of Surgeons. Calendar, Aug. 2, 1898. *The College*

Royal Colonial Institute. Proceedings, Vol. XXIX., 1897-98. *The Institute*

Royal Geographical Society. *The Geographical Journal*, Vol. XII., Nos. 3, 4, 1898. *The Society*

Royal United Service Institution. Journal, Vol. XLII., Nos. 242 - 245 1898. *The Institution*

Society of Arts. Journal, Vol. XLVI., Nos. 2389 - 2396, 1898. *The Society*

Zoological Society of London. Proceedings, Part ii., 1898. List of the Fellows &c., 31 May, 1898. Transactions, Vol. XIV., Part vii., 1898. ,,

LUXEMBOURG—L'Institut Grand-Ducal de Luxembourg. Publications (Section des Sciences Naturelles et Mathematiques), Tome XXV., 1897. *The Institute*

MADISON, Wis.—Wisconsin Academy of Sciences, Arts and Letters, Transactions, Vol. XI., 1896-97. *The Academy*

MADRAS—Madras Government Museum. Bulletin, Vol. II., No. 2, 1898. *The Museum*

MANCHESTER—Conchological Society of Great Britain and Ireland. Journal of Conchology, Vol. IX., No. 4, 1898. *The Society*

Manchester Literary and Philosophical Society. Memoirs and Proceedings, Vol. XLII., Part iv., 1897-98. ,,

MARBURG—Gesellschaft zur Beförderung der gesammten Naturwissenschaften zu Marburg. Schriften, Band XIII., Abtheil 2, 1898. Sitzungsberichte, Jahrgang 1897. ,,

Digitized by Google

MELBOURNE—*Australasian Journal of Pharmacy*, Vol. XIII., No. 155, 1898. *The Editor*

Field Naturalists' Club of Victoria. *The Victorian Naturalist*, Vol. XV., No. 7, 1898. *The Club*

Royal Geographical Society of Australasia. Transactions of the Victorian Branch, Vols. XII., XIII., 1896. *The Society*

MEXICO—Instituto Geológico de Mexico. Boletin, Num 10, 1898. *The Institute*

Observatorio Astronómico Nacional de Tacubaya. Anuario, Año XVIII., 1898. Boletin, Tomo II., Núm 2 - 4, 1897-8. *The Observatory*

Sociedad Cientifica "Antonio Alzate" Memorias y Revista, Tomo X., Nos. 5 - 12, 1896-97; Tomo XI., Nos. 1 - 8, 1897 - 1898. *The Society*

MILAN—Reale Istituto Lombardo di Scienze e Lettere. Rendiconti, Serie 2, Vol. XXX., 1897. *The Institute*

Società Italiana di Scienze Naturali e del Museo Civico di Storia Naturale in Milano. Atti, Vol. XXXVII., Fasc. 3, 1898. *The Society*

MIRFIELD—Yorkshire Geological and Polytechnic Society. Proceedings, New Ser., Vol. XIII., Part iii., 1898. „

MONTEVIDEO—Museo Nacional de Montevideo. Anales, Tomo III., Fasc. 9, 1898. *The Museum*

MONTREAL—Natural History Society of Montreal. Canadian Record of Science, Vol. VII., Nos. 5 - 7, 1897-8. *The Society*

MOSCOW—Société Impériale des Naturalistes. Bulletin, Nos. 2 - 4, 1897. „

MULHOUSE—Société Industrielle. Bulletin, Avril - Juillet, 1898. Programme des Prix a décerner en 1899. „

MUNCHEN—Akademie der Wissenschaften. Abhandlungen der Mathematisch-Physikalischen Classe, Band XIX., Abth. 2, 1898. Sitzungsberichte der Mathematisch-Physikalischen Classe, Band XXIV., Heft 4, 1894; Band XXV., Heft 1 - 3, 1895; Band XXVI., Heft 1 - 4, 1896; Band XXVII., Heft 1, 2, 1897. Ueber die wechselseitigen Beziehungen zwischen der reinen und der angewandten Mathematik von Walther Dyck, 1897. *The Academy*

NAPLES—Società Reale di Napoli. Rendiconto dell Accademia delle Scienze Fisiche e Matematiche, Ser. 3, Vol. IV., Fasc. 3, 4, 6, 7, 1898. *The Society*

Zoological Station. Mittheilungen, Band XIII., Heft 1 - 3, 1898. „

NEWCASTLE-UPON-TYNE—North of England Institute of Mining and Mechanical Engineers. An account of the Strata of Northumberland and Durham as proved by Borings and Sinkings, L - R, 1887. *The Institute*

NEW YORK—American Museum of Natural History. Annual Report for 1897. *The Museum*

New York Academy of Sciences. Annals, Vol. XI., 1898. Transactions, Vol. XVI., 1896-97 *The Academy*

Digitized by Google

NEW YORK—*continued.*
School of Mines, Columbia College. The School of Mines Quarterly, Vol. XIX., No. 4, 1898. *The College*
OTTAWA—Geological Survey of Canada. Palæozoic Fossils, Vol. III., Part iii., 1897, by J. F. Whiteaves, F.G.S. *The Survey*
PALERMO—R. Orto Botanico di Palermo. Bollettino, Anno I., Fasc. 3, 4, 1897. *The Director*
PARIS—Académie des Sciences de l'Institut de France. Comptes Rendus, Tome CXXV., Nos. 16 - 26, 1897; Tome CXXVI., Nos. 1 - 26, Tome CXXVII., Nos. 1 - 15, 1898. *The Academy*
Ecole d' Anthropologie de Paris. Revue Mensuelle, Année V., Nos. 1 - 12, 1895; Année VII., Nos. 10, 12, 1897; Année VIII., Nos. 1 - 9, 1898. *The Director*
Ecole Nationale des Mines de Paris. Statistique de l'Industrie Minérale et des appareils à vapeur en France et en Algérie pour l'année 1896. *Ministère des Travaux Publics*
Ecole Polytechnique. Journal, Série II., Cahier 2, 1897. *The School*
Feuille des Jeunes Naturalistes. Catalogue de la Bibliothèque Fasc. 22 - 24, 1897-98. Revue Mensuelle, 3 Ser., Année XXVIII., Nos. 325 - 335, 1897-98. *The Editor*
Ministère de l'Instruction Publique. Bibliographie des Travaux Scientifiques (Sciences mathématiques, physiques et naturelles) publiés par les sociétés savantes de la France, Tome I., Liv. 2. *The Minister*
Muséum d'Histoire Naturelle. Bulletin, Nos. 4, 5, 1895; No. 8, 1896; Nos. 1 - 6, 1897. *The Museum*
Observatoire de Paris. Rapport Annuel pour l'année 1897. *The Observatory*
Société d'Anthropologie de Paris. Bulletins, Série 4, Tome VII., Fasc. 6, 1896; Tome VIII., Fasc. 1 - 4, 1897. *The Society*
Société de Biologie. Comptes Rendus, Série 10, Tome IV., Nos. 31 - 40, 1897; Tome V., Nos. 1 - 30, 1898. ,,
Société d'Encouragement pour l'Industrie Nationale. Bulletin, Serie 5, Tome I., 1896. ,,
Société de Géographie. Bulletin, Sér. 7, Tome XVII., Trimestre 4, 1896; Tome XVIII., Trimestre 2, 3, 1887; Tome XIX., Trimestre 1, 2, 1898. Comptes Rendus des Séances Nos. 15 - 20, 1897; Nos. 1 - 7, 1898. ,,
Société Française de Mineralogie. Bulletin, Tome XX., Nos. 5 - 8, 1897; Tome XXI., Nos. 1 - 5, 1898. ,,
Société Française de Physique. Bulletin, Nos. 103 - 120, 1897-8. Séances, Année 1897, Fasc. 2 - 4. Recuèil de Donnés Numeriques—Optique par H. Dufet, Fasc. 1, 1898. ,,
Société Géologique de France. Bulletin, Sér. 3, Tome XXIV., Nos. 8 - 11, 1896; Tome XXV., Nos. 1 - 6, 1897. ,,
Société de Spéléologie. Bulletin, Tome III., Nos. 11, 12, 1897. ,,
Société Zoologique de France. Bulletin, Tome XXI., 1896; Mémoires, Tome IX., 1896. ,,
PENZANCE—Royal Geological Society of Cornwall. Transactions, Vol. XII., Part iii.. 1898. ,,
PERTH, W.A.—Department of Mines. Gold Mining Statistics 1897. Reports for the years 1896 and 1897. *The Department*
Geological Survey. Annual Progress Report for the year 1897. Bulletin, No. 1, 1898. Reports by the Government Geologist in connection with the Water Supply of the Goldfields. *The Survey.*

Digitized by Google

PERTH, W. A.—*continued.*
Observatory. Meteorological Report for the year 1894. *The Observatory*
Victoria Public Library. A Land of Promise—West Australia in 1897-8, (2nd Edition). Western Australian Year Book for 1896-97 (10th Edition). *The Library*

PHILADELPHIA—Academy of Natural Sciences. Proceedings, Parts ii., iii., 1897. Part i., 1898. *The Academy*
American Entomological Society. Transactions, Vol. XXIV., Nos. 3, 4, 1897; Vol. XXV., No. 1, 1898. *The Society*
American Philosophical Society. Proceedings, Vol. XXXV., No. 153, 1896; Vol. XXXVI., Nos. 155, 156, 1897; Vol. XXXVII., No. 157, 1898. "
Franklin Institute. Journal, Vol. CXLIV., Nos. 863, 864, 1897; Vol. CXLV., Nos. 1–6; Vol. CXLVI., Nos. 1–4, 1898. *The Institute*
University of Pennsylvania. Contributions from the Botanical Laboratory, Vol. I., Nos. 2, 3. University Bulletin, Vol. II., No. 5, 1898. *The University*
Wagner Free Institute of Science. Transactions, Vol. V., 1898. *The Institute*
Zoological Society. Annual Report (26th) 28 April, 1898. *The Society*

PISA—Società Toscana di Scienze Naturali. Atti, Vol. X., pp. 243 - 294, 1897; Vol. XI., pp. 1 - 10, Vol. XII., pp. 11 - 56, 1897-98. "

POLA—K. K. Kriegs-Marine-Hydrographische Amt. Relative Schwerebestimmungen durch Pendel-beobachtungen, Gruppe III., Heft 1, 1897. *The Board*

PORT LOUIS—Royal Alfred Observatory. Annual Report of the Director for the year 1896. Results of the Magnetical and Meteorological Observations made in the year 1896. *The Observatory*

PRAGUE—Königl. Böhmische Gesellschaft der Wissenschaften. Jahresbericht für das Jahr 1896, 1897. Sitzungsberichte-Mathematisch-Naturwissenschaftliche Classe, Parts i., ii., 1896; Parts i., ii., 1897. Classe für Philosophie, Geschichte u. Philologie, 1896, 1897. *The Society*

RIO DE JANEIRO—Observatoire Impérial de Rio de Janeiro. Annuario 1897, 1898. *The Observatory*
Museu Nacional. Revista, Vol. I., 1896. *The Museum*

ROME—Accademia Pontificia de Nuovi Lincei. Atti, compilati dal Segretario, Anno L., Sessione 7; Anno LI., Sessione 1 - 7, 1897-98. *The Academy*
Ministero dei Lavori Pubblici. Giornale del Genio Civile, Anno XXXV., Fasc. 5 - 12, 1897; Anno XXXVI., Fasc. 1 - 5, 1898. Osservazioni cinca gli "Appunti di un tecnico" sul coefficiente d'esercizio delle reti ferroviare Mediterranea ed Adriatica—Ing. Adolfo Rossi. *Minister for Public Instruction, Rome*
Reale Accademia dei Lincei. Rendiconti, Ser. 5, Vol. VI., Fasc. 8 - 12, Semestre 2, 1897; Vol. VII., Fasc. 1 - 12, Semestre 1, Fasc. 1 - 7, Semestre 2, 1898. Rendiconto 12 June, 1897. *The Academy*
Revista Geografica d' Italiana. Annata V., Fasc. 4 - 6, 1898. *The Publisher*
R. Ufficio Centrale di Meteorologia e di Geodinamica. Annali Serie 2, Vol. XIV., Parte ii., 1892; Vol. XVI., Parte i., 1894. *The Office*

Digitized by Google

ROME—*continued.*
Società Geografica Italiana. Bollettino, Ser. 3, Vol. X., Fasc. 10 – 12, 1897; Vol. XI., Fasc. 1 – 10, 1898. Memorie, Vol. VII., Parte i., ii. *The Society*

ST. ANDREWS—University. Calendar for the year 1898-99. *The University*

ST. LOUIS—Missouri Botanical Garden. Annual Reports (8th) 1897; (9th) 1898. *The Director*

ST. PETERSBURG—Académie Impériale des Sciences. Mémoires, Tome XLII., Nos. 13, 14, et dernier 1894; Classe Historico-Philologique, Ser. 8, Tome I., Nos. 3 - 7; Tome II., Nos. 1, 2, 1897; Classe Physico-Mathématique Ser. 8, Tome I., Nos. 1 - 8, 1894; Tome V., Nos. 2 – 13, 1896-7; Tome VI., Nos. 1 – 3, 5, 1898. Bulletin, Ser. 5, Tome V., Nos. 3 – 5, 1896; Tome VI., Nos. 4, 5, Tome VII., Nos. 1, 2, 1897. *The Academy*

Comité Géologique (Institut des Mines). Bulletins, Vol. XVI., Nos. 3 – 9 and Supplement 1897; Vol. XVII., Nos. 1 – 3, 1898. *The Institute*

Russisch-Kaiserliche Mineralogische Gesellschaft. Verhandlungen, Ser. 2, Band XXXIV., Lief. 2, 1896; Band XXXV., Lief. 1, 2, 1897-8. Systematisches Sach-und-Namen Register der Ser. II, 1885 – 1895. Materialien zur Geologie Russlands, Band XVIII., 1897. *The Society*

SALEM—American Association for the Advancement of Science. Proceedings, Vol. XLVI., 1897 (Detroit, Mich.) Preliminary Announcement of the Boston Meeting to be held August 22 to 27, 1898. *The Association*

Essex Institute. Bulletin, Vol. XXVI., Nos. 4 – 12, 1894; Vol. XXVII., Nos. 1 – 12, 1895; Vol XXVIII., Nos. 1 – 6, 1896; Vol. XXIX., Nos. 1 – 6, 1897. Historical Collections, Vol. XXX., Nos. 7 – 12, 1893; Vol. XXXI., Nos. 1 – 24, 1894; Vol. XXXII., Nos. 1 – 12, 1896, Vol. XXXIII., Nos. 1 – 12, 1897. *The Institute*

SAN FRANCISCO—California Academy of Sciences. Occasional Papers, Vol. V., 1897. Proceedings, Third Series, Geology Vol. I., Nos. 2, 3; Zoology, Vol. I., Nos. 4, 5; Botany, Vol. I., No. 2. *The Academy*

SAN SALVADOR—Observatorio Astronómico y Meteorológico. Observaciones Meteorologicas Abril 1897. *The Observatory*

SCRANTON, Pa.—Mines and Minerals, Vol. XVIII., Nos. 7 – 12, Vol. XIX., Nos. 1, 2, 1898. *The Colliery Engineer Co.*

SINGAPORE—Royal Asiatic Society. Journal of the Straits Branch, Nos. 25 - 29, 31, 1894-98. *The Society*

SOMERVILLE (Mass.)—Tufts College. Tufts College Studies, No. 5, 1898. *The College*

STOCKHOLM—Kongl. Svenska Vetenskaps Akademiens. Accessions-Katalog, 10 – 12, 1895-97, Tioars-Register 1886 - 1895. Bihang, Band XXIII., Afdelning 1 - 4, 1898. Handlingar, Band XXIX., 1896-97. Ofversigt, Vol. LIV., 1897. *The Academy*

Kongl. Vitterhets Historie och Antiqvitets Akademiens. Antiqvarisk Tidskrift för Sverige, Band XVI., Heft 4, 1895-98. Manadsblad, Arg, XXIII., 1894. ,,

Digitized by Google

STRASSBURG, i.E.—Centralstelle des Meteorologischen Landesdienstes Ergebnisse der Meteorologischen Beobachtungen im Reichsland Elsass-Lothringen im Jahre 1895. *The Director*

STUTTGART—Königliches Statistisches Landesamt. Württembergische Jahrbücher für Statistik und Landeskunde, Jahrgang 1897. Württembergischen Jahrbüchern für Statistik und Landeskunde, Ergänzungsband I., 1898. *The 'Landesamt'*

Vereins für Vaterländische Naturkunde in Württemberg. Jahreshefte, Jahrgang LIII., 1897. *The Society*

Württembergische Vereins für Handelsgeographie Jahresbericht, XV., XVI., 1896-97. „

SYDNEY—Anthropological Society of Australasia. Science of Man and Australasian Anthropological Journal, New Series, Vol. I., Nos. 1 – 3, 5 – 10, 1898. „

Australian Museum. Catalogue No. 4, Australian Birds in the Australian Museum, Parts i. and ii., Accipitres and Striges, 1874 – 1898. Memoir III., Part vi., 1898. Records, Vol. III., No. 4, 1898. Report of Trustees for 1897. *The Trustees*

Botanic Garden. Annual Report of the Director on Botanic Gardens and Domains for the year 1897. *The Director*

Department of Mines and Agriculture. *Agricultural Gazette* Vol. VIII., Part xii., 1897; Vol. IX., Parts i. – xi., 1898. Annual Report of the Department of Mines and Agriculture for the year 1897. A Manual of the Grasses of N.S. Wales by J. H. Maiden, F.L.S. Geological Survey—Memoirs, No. 6, 1898; Records, Vol. V., Part iv., Vol. VI., Part i., 1898. Mineral Resources, Nos. 1 – 4, 1898. Report on Agriculture and Forestry, 1 July 1895 to 31 December 1897. *The Department*

Department of Public Instruction. Report of the Minister of Public Instruction for 1896 and 1897. Results of Rain, River, and Evaporation Observations made in N.S. Wales during 1896 by H. C. Russell, B.A., C.M.G., F.R.S. The New South Wales Educational Gazette, Vol. VII., Nos. 7 – 12, 1897-98; Vol. VIII., Nos. 1 – 5, 1898. „

Government Printer. The Statutes of New South Wales (Public and Private) passed during the Session of 1897. *Government Printer*

Government Statistician. Annual Report on Vital Statistics for 1895, 1897, and previous years. New South Wales Statistical Register for 1896 and previous years (Bound Copy) also Part xii.; for 1897 and previous years, Parts i. – xii. The Seven Colonies of Australasia, 1897-98, Seventh Issue. Wealth and Progress of New South Wales, 1896-97, Tenth Issue. *Government Statistician*

Institution of Surveyors, N. S. Wales. *The Surveyor*, Vol. X., No. 12, 1897; Vol. XI., Nos. 1 – 11, 1898. *The Institution*

Linnean Society of New South Wales. Abstract of Proceedings, Mar. 30, April 27, May 26, June 29, July 28, Aug. 31, Sept. 28, Oct. 26, Nov. 30, 1898. Act of Incorporation, Rules, List of Members, Feb. 1898. Proceedings, Vol. XXII., Parts iii, and iv., Nos. 87, 88, 1897; Vol. XXIII., Parts i. and ii., Nos. 89, 90, 1898. *The Society*

Digitized by Google

SYDNEY—*continued.*
New South Wales Medical Board. Register of Medical Practitioners for 1898. *The Secretary*
Public Library of N.S. Wales. Annual Report (27th) of the Trustees for 1897. *The Trustees*
University of Sydney. Calendar for the year 1898. *The University*

TAIPING—Perak Government Gazette, Vol. x., Nos. 29 - 34, and Index 1897; Vol. xi., Nos. 1 - 10, 12 - 30, 1898. *The Secretary*

TOKIO—Asiatic Society of Japan. Transactions, Vol. xxiv., Supplement 1898. *The Society*
Imperial University of Japan. Calendar, 1896-97. *The University*

TORONTO—Canadian Institute. Proceedings, New Ser., Vol. i., Parts iv., v., Nos. 4, 5, 1898. Transactions, Vol. v., Part i., Supplement to No. 9; Part ii., No. 10, 1898. *The Institute*
Royal Society of Canada. Proceedings, Second Series, Vol. ii., 1896. *The Society*

TOULOUSE—Académie des Sciences, Inscriptions et Belles-Lettres. Mémoires, Serie 9, Tome viii., 1896. *The Academy*

TRENCSIN—Naturwissenschaftliche Verein des Trencsiner Komitates. Jahresheft, 1896-97. *The Society*

TROMSO—Tromso Museum. Aarsberetning for 1895 and 1896. Aarshefter, Vol. xix., 1896. *The Museum*

TUNIS—Institut de Carthage. Revue Tunisienne, Année iv., No. 16, 1897; Année v., Nos 17 - 20, 1898. *The Institute*

TURIN—R. Accademia delle Scienze di Torino. Atti, Vol. xxxiii., Disp. 1 - 15, 1897-8. *The Academy*
R. Osservatorio Astronomico di Torino. Effemeridi del Sole e della Luna per l'Orizzonte di Torino e per l'anno 1898 Calcolate dal Dottor Vittorio Balbi. La Durata dello Splendere del Sole sull' Orizzonte di Torino nota del Dott. G. B. Rizzo, 1896. Osservazioni Meteorologiche fatte nell' anno 1897 all' Osservatorio della R. Università di Torino. Pubblicazioni No. 4, 1896. *The Observatory*

UPSALA—Kongliga Vetenskaps Societeten. Nova Acta Regiæ Societatis Scientiarum Ser. 3, Vol. xvii., Fasc. 2, 1898. *The Society*

VIENNA—Anthropologische Gesellschaft in Wien. Mittheilungen, Band xxvii., Heft. 4 - 6, 1897; Band xxviii., Heft 1, 2, 1898. "
K.K. Central-Anstalt für Meteorologie und Erdmagnetismus. Jahrbücher, Band xxxi., xxxii., xxxiii., 1894-96. *The Station*
K. K. Geographische Gesellschaft. Mittheilungen, Band xl., 1897. *The Society*
K. K. Geologische Reichsanstalt. Jahrbuch, Band xlvii., Heft 2 - 4, 1897. Verhandlungen, Nos. 9 - 18, 1897; Nos. 1 - 12, 1898. *The "Reichsanstalt"*
K. K. Gradmessungs-Bureau Astronomische Arbeiten, Band ix., 1897, Längenbestimungen. *The Bureau*
I. R. Osservatorio Astronomico-Meteorologico. Rapporto Annuale per l'anno 1895. *The Observatory*
K. K. Naturhistorische Hofmuseums. Annalen, Band xii., Nos. 1 - 4, 1897. *The Museum*

Digitized by Google

VIENNA—*continued.*

K. K. Österreichische Gradmessungs-Commission. Verhandlungen-Protokoll 21 April, 1897. *The Commission*

Section für Naturkunde des Österreichischen Touristen-Club. Mittheilungen, Jahrgang IX., 1897. *The Section*

K. K. Zoologisch-botanische Gesellschaft. Verhandlungen, Band XLVII., Heft 1 - 10, 1897. *The Society*

WASHINGTON—American Historical Association Annual Report for the year 1896, Vols. I., II. *The Association*

Bureau of Education. Report of the Commissioner of Education for 1895-6, Vols. I., II.; 1896-7, Vol. I. *The Commissioner*

Bureau of Ethnology. Annual Report of the Director, (16th) 1894-5. *The Director*

Department of Agriculture. Division of Agrostology—Bulletin, Nos. 1, 2, 4, 5, 6, 9, 1895-97; Circular, Nos. 1, 2. Division of Biological Survey—North American Fauna, No. 13, 1897. Division of Botany—Circular No. 13. Division of Vegetable Physiology and Pathology—Bulletin, Nos. 14, 15. Division of Statistics—New Series, Report Nos. 153 - 155. Farmers' Bulletin, Nos. 18, 20, 31, 37, 50, 58, 66, 75; Crop Circular, May - Oct. 1898, Weather Bureau—Monthly Weather Review, Vol. XXV., July - Dec. and Annual Summary for 1897; Vol. XXVI., Jan. - July, 1898; Bulletin D., Rainfall of the United States. Year Book 1896-1897, and 5 Reprints. *The Department*

Department of the Interior (Census Office). Compendium of the Eleventh Census, 1890, Part iii. Report on Population of the United States at the Eleventh Census, 1890 Part ii. Report on Vital and Social Statistics, Part i. Analysis and Rate Tables. Statistical Atlas of the United States, based upon results of the Eleventh Census. "

Engineer Department, U.S. Army. Annual Report of the Chief of Engineers, Parts i. - vi., 1897. "

Smithsonian Institution. Annual Report of the Board of Regents 1894-5. Report of the U.S. National Museum, 1893, 1894, 1895. Smithsonian Miscellaneous Collections, Vol. XXXVII., No. 1087; Vol. XXXVIII., Nos. 1084, 1090; Vol. XL. *The Institution*

U.S. Coast and Geodetic Survey. Report of the Superintendent, Fiscal Year ending with June 1896, Parts i. and ii. *The Survey*

U. S. Geological Survey. Annual Report (17th) to the Secretary of the Interior 1895-6, Part i. Director's Report and other papers; Part ii. Economic Geology and Hydrography. Bulletin, Nos. 87, 127, 130, 135 - 148, 1896-97. Monographs—XXV., The Glacial Lake Agassiz; XXVI., The Flora of the Amboy Clays.; XXVII., Geology of the Denver Basin in Colorado; XXVIII., The Marquette Iron-bearing district of Michigan. "

U. S. Hydrographic Office. Chart No. 1531 The Arctic Regions with the tracks of search parties and the progress of

Digitized by Google

WASHINGTON—*continued.*
discovery. Graphical Method for Navigators by Commander C. D. Sigsbee, U.S.N. Notice to Mariners, Nos. 19, 32 – 52 and Index 1897; Nos. 1 – 31, 1898. *U.S. Hydrographer*

U. S. Navy. Report of the Surgeon-General, 1897. *The Secretary of the Navy*

WELLINGTON N. Z.—Mines Department. Annual Report (31st) of the Colonial Laboratory, 1896-97. *The Department*

New Zealand Institute. Transactions and Proceedings, Vol. XXX., 1897. *The Institute*

Polynesian Society. Journal, Vol. VI., No. 4, 1897; Vol. VII., Nos. 1, 3, 1898. *The Society*

WINNIPEG—Historical and Scientific Society of Manitoba. Annual Report for the year 1896. Transactions, Nos. 49 and 50, 1897. ,,

ZURICH—Naturforschende Gesellschaft. Neujahrsblatt auf das Jahr 1898. Vierteljahrsschrift. Jahrgang XLII., Heft 3, 4, 1897; Jahrgang XLIII., Heft 2, 3, 1898. ,,

MISCELLANEOUS.

(Names of Donors are in *Italics.*)

Ashley, George H., PH. D.—Geology of the Paleozoic Area of Arkansas, South of the Novaculite Region, 1897. *J. C. Branner, PH.D.*

Australasian Medical Gazette, Vol. XVII., Nos. 1 – 11, 1898. *G. Lane Mullens, M.A., M.D.*

Ball, Sir Robert, LL.D., D.Sc., F.R.S.—The Twelfth and concluding Memoir on the Theory of Screws, with a Summary. *The Author*

Bernice Pauahi Bishop Museum of Polynesian Ethnology and Natural History—Occasional Papers, Vol. I., No. 1, Director's Report. [8° Honolulu, 1898.] *The Director*

Boletin de Estadistica del Estado de Puebla, Epoca II., Núms. 1 and 3, 1897. *The Redactor*

Branner, John C., PH.D.—Geology in its relations to Topography. The former extension of the Appalachians across Mississippi, Louisiana, and Texas. *The Author*

Campion, Henry—The Secret of the Poles, 1898. ,,

Colenso, Rev. W., F.R.S., F.L.S.—A Maori-English Lexicon: being a comprehensive dictionary of the New Zealand Tongue, 1898. ,,

Conklin, Edwin Grant—The Embryology of Crepidula, 1897. ,,

Dimmock, Dr. George, and Ashmead, William H.—Notes on parasitic hymenoptera, with descriptions of some new species, 1898. *Dr. George Dimmock*

Dollfus, G. F.—Paléozoologie Générale, 1897. *G. Ramond*

Electrical Engineer, February 11 to October 21, 1898. *The Publishers*

Fritsche, Dr. H.—Observations magnétiques sur 509 lieux faites en Asie et en Europe pendant la période de 1867 – 1894. *The Author*

Helios, 15 Oct., 15 Dec. 1896, 1 Dec. 1897, 1 Sept. 1898. *The Publishers, Leipzig*

Digitized by Google

Hucke, Julius—Die Geld-Verrichtungen in der Breis, Lohn-und Zinsgestaltung, 1897. *The Author*

Illustrirte Aëronautische Mittheilungen, No. 3, 1898. *The Publishers, Strassburg i.s.*

Kosmopolan—List of Contents, 1891 - 1897 incl. *The Publisher*

Lespagnol, G.—Sur de Charactère Désertique de l'Australie intérieure. *The Author*

Liversidge, A., M.A., LL.D., F.R.S.—Abbreviated names for certain crystal forms. Models to show the axes of crystals. Experiments on the waterproofing of bricks and sandstones with oils. Experiments on the porosity of plasters and cements. Variation in the amount of free and albuminoid ammonia in waters, on keeping. On the corrosion of aluminium. Crystallised carbon dioxide. On the internal structure of gold nuggets. Contributions to the bibliography of gold. On some New South Wales and other minerals (Note No. 7). On the amount of gold and silver in sea-water. The removal of silver and gold from sea-water by Muntz metal sheathing. Papers and reports. Presidential Address at the Seventh Session of the Australasian Association for the Advancement of Science, January 6, 1898. "

Marcou, Jules—Jura and Neocomian of Arkansas, Kansas, Oklahoma, New Mexico, and Texas. Note sur le Tithonique-Wealdien. "

Mullins, George Lane, M.A., M.D.—Tuberculosis and the Public Health. "

Museum d'Histoire Naturelle—Guide dans la Collection de Météorites avec le Catalogue des chutes representées au Museum, 1898. *G. Ramond*

Nangle, James, F.I.A.—Some Notes on Sydney Building Stones. *The Author*

Peek, Cuthbert E., M.A., F.R. Met. Soc.—Meteorological Observations at the Rousdon Observatory, Devon, for the year 1896, Vol. XIII. "

Pelatan, Louis—Les Mines de la Nouvelle-Calédonie. *C. Hedley, F.L.S.*

Piette, Ed., et Porterie, J. de la—Etudes d'Ethnographie Préhistorique fouilles a Brassempouy, en 1896. *Ed. Piette*

Ramond, G.—Etude Géologique de l'Aqueduc de l'Avre, 1896. Notice Nécrologique sur Sir Joseph Prestwich 1812–1896. Trilobites, 1898. *The Author*

Report on the condition and progress of the G. V. Juggarow Observatory, Vizagapatam, including the results of Observations for the year 1896. *The Committee*

Report of the Director of the Observatory to the Marine Committee and Meteorological results deduced from the Observations taken at the Liverpool Observatory, Bidston, Birkenhead, in the year 1897. *The Mersey Docks and Harbour Board*

Royal Societies' Club, London.—Foundation and Objects, Rules and By-laws, List of Members, 1897. *Lieut. M. W. Campbell Hepworth, R.N.R., F.R.A.S., F.R.M.S.*

Schenck, Rudolf, Ph. D.—Untersuchungen über die Krystallinischen Flüssigkeiten, 1897. *The Author*

Digitized by Google

Tebbutt, John, F.R.A.S.—Results of Meteorological Observations made at the Private Observatory of John Tebbutt, The Peninsula, Windsor, N.S. Wales in the years 1891, 1892, 1893, 1894, 1895, 1896 and 1897. *The Author*

Tepper, J. G. O., F.L.S., &c.—The Influence of Vegetation on Climate and the Rainfall, 1898. ,,

The Library World, Vol. I., Nos. 1, 2, 1898. *The Library Supply Co., London*

The Locomotive, Vol. XVIII., Nos. 8 - 11, 1897. *Kegan, Paul, Trench, Trübner & Co., Ld.*

Westralia, South Western Districts, Parts i. and ii., 1898. *Publishers of the Geraldton Express*

PERIODICALS PURCHASED IN 1898.

American Journal of Science, (Silliman).
American Monthly Microscopical Journal.
Analyst.
Annales des Chimie et de Physique.
Annales des Mines.
Annals of Natural History.
Astronomische Nachrichten.
Athenæum.
Australian Mining Standard.

British Medical Journal.
Building and Engineering Journal of Australia and New Zealand.

Chemical News.
Curtis's Botanical Magazine.

Dingler's Polytechnisches Journal.

Electrical Review.
Engineer.
Engineering.
Engineering and Mining Journal.
Engineering Record and Sanitary Engineer.
English Mechanic.

Fresenius Zeitschrift für Analytische Chemie.

Geological Magazine.
Glacialists' Magazine.

Industries and Iron.

Journal de Médecine.
Journal of Anatomy and Physiology.
Journal of Botany.
Journal of Morphology.
Journal of the Chemical Society.
Journal of the Institution of Electrical Engineers.
Journal of the Royal Asiatic Society of Great Britain and Ireland.
Journal of the Society of Chemical Industry.

Knowledge.

L' Aéronaute.
Lancet.

Digitized by Google

Medical Record of New York.
Mining Journal.

Nature.
Notes and Queries.

Observatory.

Petermann's Ergänzungsheft.
Petermann's Geographischen Mittheilungen.
Philosophical Magazine.
Photographic Journal.
Proceedings of the Geologists' Association.

Quarterly Journal of Microscopical Science.

Sanitary Record.
Science.
Science Progress.
Scientific American.
Scientific American Supplement.

Zoologist.

BOOKS PURCHASED IN 1898.

American Journal of Science, (Silliman) 3 Ser., Vols. I. - X. and Index.
Australian Handbook, 1898.

Boulenger's Tailless Batrachians of Europe, Parts i., ii. (*Ray Society* 1896-7).
Braithwaite's Retrospect of Medicine, Vols. CXVI., CXVII., 1897-8.
British Association Reports, 1895 and 1897.
Buckler's Larvæ of British Butterflies and Moths, Vol. VII. (*Ray Soc.* 1894).

Cassell's French and German Dictionaries 1897.

Glacialists' Magazine, Vol. III., Part iv.; Vol. IV., Parts ii. - iv.; Vol. V, Parts i., ii., iii.

International Scientific Series, Vol. LXXXV.

Leprosy, Prize Essays on—Ashburton Thompson, Cantlie. (*New Syd. Soc.*, Vol. CLXII.)

Medical Officers' Annual Report for 1895-96.
Medico-Chirurgical Society, Transactions, Vol. LXXX., 1897.
Milne, John—Seismology. (*Int. Sci. Ser.*, Vol. LXXXV.)

New Sydenham Society's Publications, Vols. CLXI., CLXII., CLXIII., CLXIV.

Obstetrical Society—Transactions, Vol. XXXIX., 1897.
Official Year Book of Scientific and Learned Societies, 1898.

Palæontographical Society, Vols. XLIX., L., LI.
Pathology, Atlas of Illustrations of, Fasc. XI. (*New Syd. Soc.*, Vol. CLXIII.)

Ray Society's Publications for 1894, 1896, 1897.
Royal Colonial Institute, Proceedings, Vol. III., 1872.

Selected Essays and Monographs. (*New Syd. Soc.*, Vol. CLXI.)

Vaccination and its Results. (*New Syd. Soc.*, Vol. CLXIV.)

Whitaker's Almanack 1898.

Digitized by Google

PROCEEDINGS OF SECTIONS.

Digitized by Google

Digitized by Google

PROCEEDINGS OF THE SECTIONS
(IN ABSTRACT.)

ENGINEERING SECTION.

The first monthly meeting of the Session was held in the Large Hall of the Society's House on May 18th, 1898, at 8 p.m., when there were present Mr. T. H. HOUGHTON, M. Inst. C.E., (in the Chair) and thirty-six members and visitors.

The Chairman delivered his presidential address.

A vote of thanks to the Chairman was moved by Mr. C. W. DARLEY, seconded by Mr. T. R. FIRTH, and carried by acclamation.

Monthly meeting held June 15.

There were present Mr. T. R. FIRTH (in the Chair), and fourteen members and visitors.

Mr. C. O. BURGE read a paper on "The narrow gauge as applied to Branch Railways in N.S.W."

Mr. J. I. HAYCROFT read a paper on "Engineering Construction in connection with Rainfall."

Monthly meeting held July 20.

There were present Mr. T. H. HOUGHTON (in the Chair) and eighteen members and visitors.

The discussion on Mr. BURGE's paper read at the previous meeting was opened by Mr. H. Deane and continued by Messrs. B. C. Simpson, E. W. Young, J. I. Haycroft, and the Chairman, and replied to by the author.

The discussion on Mr. HAYCROFT's paper read at the previous meeting was opened by Mr. C. O. Burge, and continued by Mr. B. C. Simpson and Mr. E. W. Young, and then adjourned to the following meeting.

The Chairman announced that the roll of members of the Section was about to be revised, and requested members of the

Digitized by Google

Society who desired to be enrolled to leave their names with the Hon. Secretary of the Section.

Monthly meeting held August 17.

There were present Mr. C. O. BURGE (in the Chair), and twenty-two members and visitors.

The adjourned discussion on Mr. HAYCROFT'S paper was continued by Messrs. G. H. Knibbs, J. H. Cardew, J. Davis, C. J. Merfield, B. C. Simpson, and the Chairman.

At the request of the Chairman the Hon. Secretary read contributions to the discussion by Prof. KERNOT and Mr. G. CHAMIER. The discussion was adjourned to the following meeting.

Monthly meeting held September 21.

There were present Mr. T. H. HOUGHTON (in the Chair) and thirteen members and visitors.

Mr. NORMAN SELFE read a paper on "A Pile Wharf in Deep Water."

The adjourned discussion on Mr. HAYCROFT'S paper was continued by Prof. Warren and Mr. C. J. Merfield, and replied to by the author.

Monthly meeting held October 19.

There were present Mr. T. H. HOUGHTON (in the Chair) and seventeen members and visitors.

The Hon. Secretary read a paper entitled "Notes on Hydraulic Boring Apparatus," by Mr. G. H. HALLIGAN, and the author explained in detail various pieces of boring apparatus which he had brought to illustrate his paper.

The discussion on Mr. N. SELFE'S paper was opened by Mr. H. Deane, and continued by Messrs. Shaw, Ross, Haycroft, and Barraclough, and replied to by the author.

At the invitation of the Chairman, Prof. DAVID described various pieces of boring apparatus with which he had had practical experience, more especially in connection with the Funafuti bores.

Digitized by Google

Monthly meeting held November 16.

There were present Mr. T. H. HOUGHTON (in the Chair) and thirty-six members and visitors.

The discussion on Mr. HALLIGAN'S paper was continued by Mr. Deane and replied to by the author.

At the invitation of the Chairman, Prof. THRELFALL delivered an address entitled "Notes on Matters connected with Engineering in England."

Mr. H. DEANE moved a cordial vote of thanks to Prof. Threlfall for his address, and expressed the deep regret of the members at his early departure from Australia.

Mr. P. B. ELWELL seconded the motion which was carried with acclamation. Prof. Threlfall in replying thanked the members of the Section for the cordial welcome they had always extended to him.

The Chairman requested that members who were desirous of suggesting names for the Committee for the following Session should communicate with the Hon. Secretary.

Monthly meeting held December 21.

There were present Mr. T. H. HOUGHTON (in the Chair) and twelve members and visitors.

The following members were elected as the Committe for the following year :—Chairman : H. R. CARLETON, M. Inst. C.E. Hon. Secretary and Treasurer: S. H. BARRACLOUGH, M.M.E., Assoc. M. Inst. C.E. Committee: H. DEANE, M.A., M. Inst. C.E., NORMAN SELFE, M. Inst. C.E., PERCY ALLAN, Assoc. M. Inst. C.E., G. R. COWDERY, J. M. SMAIL, M. Inst. C.E., J. I. HAYCROFT, M.E., M. Inst. C.E. I.

Mr. CARLETON'S paper on "Lighthouses in N.S.W." was discussed by Mr. Grimshaw, Capt. Hepworth, and Mr. Ollife.

Prof. WARREN read a paper on "A Testing Machine for equal alternating stresses," which was discussed by Messrs. Grimshaw, Shaw and the Chairman.

Digitized by Google

MEDICAL SECTION.

I.

A Special Meeting of the Medical Section of the Royal Society was held at the Society's House, 5 Elizabeth-street North, Sydney, at 8 p.m., on May 20th, 1898.

The object of the Special Meeting being the election of officers for the Session 1898-9.

Dr. J. ASHBURTON THOMPSON the retiring Chairman presided.

The following were elected officers of the Section, unopposed:—Chairman: Dr. G. E. RENNIE. Committee: Dr. G. LANE MULLINS, Dr. J. ASHBURTON THOMPSON, Dr. F. H. QUAIFE, Dr. SYDNEY JAMIESON. Hon. Secretaries: Dr. J. ADAM DICK, Dr. FRANK TIDSWELL.

The retiring Chairman was cordially thanked for his able services during the past Session.

II.

An Ordinary Meeting of the Medical Section of the Royal Society of N. S. Wales, was held at the above address immediately after the close of the Special Meeting.

In the absence of the Chairman of the Section (Dr. G. E. RENNIE) the meeting was presided over by Dr. J. ASHBURTON THOMPSON. There was a fair attendance of members.

Dr. J. ADAM DICK exhibited an apparatus of local manufacture for the production of Formic Aldehyde Gas for purposes of Disinfection. The apparatus was made by Lichtner & Co. of Sydney. Dr. Dick explained the working of the apparatus and the application of the gas. Dr. Frank Tidswell discussed the subject of formic aldehyde and the various means employed in its production and its value as a disinfectant. Drs. Quaife, Jamieson, and Pope also discussed the subject.

III.

An Ordinary Meeting of the Medical Section was held at the Society's House, on August 19th, 1898 at 8·15 p.m. Present the

Digitized by Google

Chairman of the Section Dr. G. E. RENNIE and about forty members and visitors.

Dr. FRANK TIDSWELL exhibited several microscopical specimens illustrating different varieties of Leucocytes.

Dr. SYDNEY JAMIESON exhibited several specimens recently added to the University Museum of Normal Anatomy.

A paper upon "Disinfection of Dwellings in Notifiable Infectious Diseases,"[1] was read by Dr. W. G. ARMSTRONG the Medical Officer of Health for the Metropolitan Combined Districts. (By invitation).

An interesting discussion followed the reading of the paper in which the following took part:—Drs. Ashburton Thompson, W. H. Goode, Fiaschi, F. H. Quaife, Clubbe, Frank Tidswell, Hinder, Camac Wilkinson, and Spencer.

The hour for concluding the meeting having arrived, on the proposal of Dr. SPENCER, seconded by Dr. WILKINSON, it was resolved that the discussion be continued at the next meeting.

IV.

An Ordinary Meeting of the Medical Section was held at the Society's House, on Friday, October 21st, at 8·15 p.m.

There was a small attendance of members due no doubt to the stormy weather at that time.

In the absence of the Chairman of the Section (Dr. G. E. RENNIE) it was proposed and carried that Dr. WALTER SPENCER be elected to preside.

Dr. FREDERICK MILFORD exhibited and explained the use of a new form of "Interdental Splint," for use in cases of fracture of the jaw. The subject was discussed by Drs. Fiaschi, Camac Wilkinson, and Messieurs Lugg, (visitor) Reading, and Hodgson.

A paper was read by Dr. FIASCHI, entitled "Notes on two cases of Amputation of the Rectum for Extreme Prolapsus."[2] Drs.

[1] Vide "Australasian Medical Gazette," Sydney, 1898.
[2] Vide "Australasian Medical Gazette," Sydney, 1898.

Digitized by Google

Camac Wilkinson, Adam Dick and the Chairman discussed the subject.

The continuation of the discussion upon Dr. W. G. Armstrong's paper upon "Disinfection of Dwellings in Notifiable Infectious Diseases," was resumed by Dr. Walter Spencer, followed by Dr. Camac Wilkinson, and J. Adam Dick. Dr. W. G. Armstrong replied. The meeting then terminated.

Owing to there not being sufficient material forthcoming and to the holidays other meetings of the Section were not held.

Digitized by Google

ANNUAL ADDRESS.

By T. H. HOUGHTON, M. Inst. C.E., M.I.M.E.

[*Delivered to the Engineering Section of the Royal Society of N. S. Wales, May 18th, 1898.*]

I HAVE to thank you for the honour you have done me by electing me Chairman for this session. My predecessors in the chair have done much to raise the importance of the Engineering Section of the Royal Society, and I feel sure that I shall have your cordial co-operation in my endeavours to maintain its present position. I cannot hope to increase its importance by anything I can do myself, but it lies with members to do that by attending the meetings, reading papers, and joining in the discussions. The prominent position held by papers on engineering subjects in the "Volume of Transactions for 1897," there being fully one-third of the book taken up by them, is greatly to the credit of this section.

It is not necessary that papers should be lengthy; short ones describing some particular feature of important works often contain a large amount of information. Few of us care to admit having made failures, but undoubtedly they do occur, and descriptions of them, together with their probable cause, would do much to spread information, and I think that the kindly criticism evoked would often be of assistance to the author.

During the past year nine Engineers have joined, or been proposed, as members of the Royal Society, instigated chiefly, no doubt, by the advantage of attending the meetings of this section, and the Council, recognising the great importance of Engineering, have, for the past two years, printed the papers read before this Section as a part of their annual volume; in fact, at all times they have shewn their readiness to help us as a body, whether members of the Royal Society or not, for they have always allowed the free use of this hall for meetings of the members of

Digitized by Google

the Inst. C.E. resident in this Colony, and this fact should induce those members of the Institution who are not already members of the Society to send in their proposals for membership, and so increase the roll of the Society which is so ready to oblige us in every way.

The difficulty of finding a subject for my opening address has confronted me, as it will, no doubt, my successors, for year by year, with the multiplication of scientific societies, each one dealing with a speciality, it becomes more difficult to find a non-debatable subject of sufficient interest. I would, however, like, with your permission and consideration, to occupy your attention for a short while to-night.

There have been few large works initiated or completed during the past year in this or the neighbouring colonies. In Western Australia the Fremantle Harbour Works are still in progress, and work has been commenced on the great scheme for supplying the Coolgardie district with water. A considerable amount has been expended upon railway construction, and further large extensions are under consideration, some by private enterprise. The expenditure for Public Works in Western Australia amounted in 1897 to £2,325,000, having risen from less than £800,000 in 1895. In addition to this large sum the amount expended by private companies upon works has been very large, so that, although as regards population it is the smallest of the five colonies, yet it has, during the past year, probably afforded greater scope for the exercise of our profession than any of the others.

In South Australia there is little to record. A scheme is being formulated to construct a large reservoir at Bundaleer to increase the supply in the area now supplied from Betaloo. In connection with the Adelaide Water Supply, some mains are being laid of a new type; they are made from steel plates without any riveting being required. As this is the first occasion upon which such pipes have been used in Australia, a short description of them and the method adopted in their manufacture will perhaps be interesting.

Digitized by Google

The plates from which the pipes are made are of the length required for each pipe, and of the width nearly equal to the circumference for small pipes, the larger ones being made with two or more plates. In the first place they are bolted down in the bed of a heavy planing machine and planed to the exact width, the two longitudinal edges are, at the same time, pressed together or upset, as it is termed, so as to make them of a dovetail section; the plate is then a flat one with thickened edges. It is now put into a press which bends a short distance from the edges to the radius of the pipe—as in rolling it is found that the rolls will not properly bend close up to the edge—and after this preliminary bending the plate is ready for rolling into the circular form. It is now necessary to join the two edges; this is done by inserting between them a bar of soft steel of a X section, the sides of this X section are then pressed in towards each other under a heavy vertical pressure, and thus grip the thickened edges of the plate, forming a water-tight joint which has, I understand, withstood all the tests required. Time alone can prove whether this system of making steel pipes is more satisfactory than that of riveting them, which has been brought to such excellence in this city.

The scheme for an Outer Harbour at Largs Bay is again being brought forward by influential people, and if carried out will mean the expenditure of a large sum of money. Electric lighting has not made much advance in South Australia, but recently large concessions have been granted to an English syndicate for supplying light and power.

One of the most important Engineering works in South Australia, of recent years, has been the erection at Port Pirie of the smelting furnaces removed from the Broken Hill Mines, so as to be at the sea board, thus insuring, for many years to come, constant employment for a large population.

Coming eastward to Victoria there is little to record, the construction of the Melbourne Sewerage Works being the most important of any works in progress; they are approaching

Digitized by Google

completion, and already a large number of dwellings are connected to them; many difficulties have been met with during their construction, and unfortunately some loss of life has occurred, but now all the serious difficulties have been overcome.

In the Melbourne Main Sewers now being made, a system has recently been adopted which largely reduces the cost of construction in bad ground, by substituting for cast iron segments, previously used, others built of wood, forming ribs with outside lagging; this improvement is said to reduce the cost by over 20 per cent. Besides the lessening of the cost, greater efficiency is stated to have been secured, owing to the new lining being much more impervious to the flow of water from the outside, than the joints in the cast iron. This is a very important factor in securing the water-tightness of the concrete or sewers proper, and will, no doubt, lead to its adoption in ground carrying water, even if it is not bad enough to require the protection of the the lining to enable the concrete to be put in.

Melbourne has, up to the present, utilised electricity for lighting to a greater extent than any other Australian city. The Council having erected a large station for street lighting purposes some years ago, are now proposing to buy up the two large private companies who supply light in the City and some of the more important suburbs, thus securing the control of both street and house lighting.

In Tasmania there are several railways being made by private companies, intended to develope the mineral wealth of the West Coast district, and the Tasmanian Government has recently finished a considerable length of narrow gauge line* through heavy country in the neighborhood of Zeehan; on the railway connecting Mount Lyell with the coast the Abt system will be used, on the heavy grades.

In Queensland the completion of the Brisbane Electric Trams has been one of the most important works. A large bridge is being built at Rockhampton over the Fitzroy river to connect

* See proceedings Australasian Society for the Advancement of Science, 1898.

Digitized by Google

the Central Railway with Broadmount, at the mouth of the river, and a contract has been recently let for a large bridge over the Burnet at Bundaberg.

A large amount of money is being expended in developing the Sugar and Meat industries in that colony, the Government advancing large sums to the various companies concerned; as to the wisdom of such a course I will not venture to express an opinion, but the result has been the stimulation of enterprise, and that is what we, as engineers, depend upon.

To come to our own colony there is not much to add to the works to which Mr. Burge called your attention a year ago when taking this chair, and as we are most interested in what the future has in store for us, it is to works that still have to be carried out that I will first call your attention. Prominent amongst them is the City Railway. The proposal to bring it to Hyde Park was the one favored by those in authority, and who, from their position, were most likely to be acquainted with all the requirements of the service, but amongst many engineers unconnected with the Government there is a feeling that it would be better to adopt a more comprehensive scheme and avoid taking any of Hyde Park. The exhaustive inquiries held on this subject have resulted in the decision that Hyde Park, at least a portion, is to be given up for Railway purposes, and if no better route can be found, which will be acceptable to those who will have to work it and make it pay, it will be best to accept what will undoubtedly be a very great improvement upon the existing arrangement, instead of striving for what may be the perfect scheme, but one which will be delayed for years.

Another work in which employment will be provided for our profession is that of lighting the city and the suburban districts by electricity and supplying motive power; the number of small installations is yearly increasing and may interefere with the success of a central station if allowed to multiply, for these installations are in the best paying blocks of the City. A large demand would arise for power for small industries where manual

Digitized by Google

labor is now employed if such a readily controlled and easily installed power as electricity were obtainable.

There is one advantage we possess in hastening slowly in Sydney, in that whatever authority constructs the works for supplying electricity, they will, I hope, be able to avoid such an unsightly view as is seen in some cities with the overhead wires. The introduction of the incandescent gas burners for street lighting may have the effect of delaying the advent of electricity for a few years, for the streets of few cities are better lighted than are those of Sydney.

The construction of refuse destructors, not only for the city, but for many other portions of the colony, is one that demands attention. It has been under consideration for many years, and much information is available on the subject; the reluctance displayed by the various councils to grapple with the subject may be due to their desire to await the development of such a system as will ensure them a supply of steam for the generation of electricity, but although it is possible in England and some of the cities of America to utilize surplus heat from the destructors, it is improbable that the refuse collected in Australian towns will have as high a calorific value as that in colder climates, where coal is chiefly used as domestic fuel, and, besides, it is only under exceptional conditions that the heat obtained would be of a large amount.

A large installation has been recently put to work in London with the destruction of refuse and generation of electricity combined, but as the burning of refuse has to be continuous day and night, and the maximum demand for electricity is only for a short period each day, storage has to be provided for the heat produced during the remainder of the day, so that it can be employed during the period of maximum demand.

The sewerage of the larger towns of the colony will have to be taken in hand at some not far distant date, and should afford employment for many engineers; in some cases it would most probably be found that where the population is fairly concentrated

Digitized by Google

the annual cost to the ratepayer would not be much in excess of the present unsatisfactory system, for the constantly increasing biological knowledge has shown us how the work of dealing with the crude sewage can be satisfactorily and cheaply performed by utilising the means nature has placed at our disposal.

Among other matters, which, as an Engineer, I hope to see accomplished, is the passing of a satisfactory Local Government Act, and also of an Act dealing with steam boilers, but not, I trust, one to place the inspection in the hands of a Government Department, as proposed in the Bill brought before the Parliament recently. An Act modelled on the English laws would suit all requirements.

Amongst the works that are in progress the most important is undoubtedly the Sewerage of Sydney which is being carried on by the Departments concerned, the number of houses connected to it being over 50,000, with an estimated population of 250,000. The total cost of the system when completed will, it is stated in the report of the Royal Commission which sat last year, be £3,463,486, of which the sum of £1,200,000 was unexpended last June. The North Sydney out-fall works at Willoughby Bay are nearly finished, and as they involve several features which have not been used in Australia before, a short description may prove interesting.

The sewer discharges into screening chambers, in which all the large floating matter will be screened out; lime will be then added to that portion which passes through the screen and be thoroughly mixed with it, the mixture then flowing into a tank in which to settle and deposit the sludge; after settlement, the supernatant water will be drawn off by a floating off-take and delivered on to some portion of a large filter bed of about thirteen acres in extent, formed of sand dredged from the harbour and deposited by the sand-pumps. At a depth of about 4ft., and half a chain apart perforated glazed earthenware pipes have been laid in the sand and connected with a main drain to collect the filtrate and discharge it into the Bay. The trenches in which these pipes are

Digitized by Google

laid are filled for a portion of the height with small coke breeze so as to prevent the fine sand entering the holes in the pipes. The sludge which will be deposited in the settling tanks will be discharged into a sludge chamber, where, after further settlement, it will be forced into a filter press by compressed air, where almost all the remaining moisture will be driven out. Two destructors with a tubular boiler set between them have been provided for burning the matter caught on the screens and the cakes of sludge, but as neither material would burn without the addition of fuel it is intended to mix them with refuse coke from the gas-works. The steam generated in the boiler will drive the air compressor, which is used for elevating the sludge and pressing it. Probably the sludge will have some manurial value and may be disposed of to market gardeners instead of being burned.

Many districts of Sydney are too low to drain into the main sewers, and in consequence the sewerage will have to be pumped from the low level to the high level sewer. At Marrickville, two large pumping engines, each capable of raising 3000 cubic feet of sewerage per minute, are to be erected, with the necessary steam boilers and buildings. At the Double Bay Station a different system has been adopted. Shone's ejectors are to be used, the air for working them being compressed at the Station containing the ejectors by compressors driven by electric motors, the current being supplied from the Rushcutter Bay power house. Ingenious arrangements for stopping and starting the motor automatically, as the level of sewage in the sump varies, have been provided. At the other low level sewers reciprocating or centrifugal pumps driven direct by electric motors will be used, thus saving both in cost of working and first cost compared to the system adopted at Double Bay.

The current for driving these motors will be supplied from the Harris Street Generating Station, and, instead of there being an automatic controller at each pumping station, a man will be stationed in some convenient place where dials electrically connected to the sumps in which the pumps are to be placed will

Digitized by Google

record the height of sewage in them; he will then be able to regulate the working of the pump without leaving his station, thus concentrating the control all in one place.

Power for the electric trams is to be generated at the station in Harris Street. It is, I believe, in the first place intended to erect engines of a total capacity of 5000 h.p. to be afterwards extended to 20,000, as the extension of the system of electric propulsion takes place, and sufficient power has been provided to drive the various sewage pumps.

There are now at work or under construction a total of fifteen miles of single track electric tramway, and two short lines at North Shore are contemplated. Power for the Willoughby and Mosman Bay trams is provided at the Cable Power House, North Sydney, and for the Rose Bay line from the Rushcutter Bay Power House, the generators in both cases being driven by the engines driving the tram cables. On the completion of the large station at Harris Street, it is intended to close the power station at North Shore and convey sufficient current from Harris Street by a submarine cable to the opposite shore, the present cable tram being converted into an electrical one.

There are many very important features in connection with what is termed the George Street tram, but which is, I hope, only the commencement of an improved system of trams throughout the city; in an address like this I cannot refer to them all. I trust that we will have them fully described in a paper to be read before us by some member connected with their construction. A conduit for the injection water is being constructed from Darling Harbour to the Generating Station, so that by making them condensing, the utmost economy can be attained in the engines. Owing to the large area of ground required for the station, it was cheaper to go to this expense than to build it on land adjoining the Harbour, and, besides, the question of convenience in handling the large amount of coal that will be required when all the engines are at work, probably over 150 tons a day, had to be considered, and as that requirement could

Digitized by Google

be best filled by the site chosen, the cost of a long conduit was justifiable.

The poles for carrying the trolley wires are new to Australia, in fact, they have only recently been introduced in America. They are made from solid drawn weldless Mannesman tubes, each of three different diameters drawn out of one piece of steel, and will present a graceful appearance when fixed with the cast iron base and ornamental brackets to carry the trolly wire, which is itself of a special form, being deep and narrow, instead of round as in the tramways previously constructed here.

Preparations have been made in portions of the existing steam tramway system for the transformation of them into electric ones when they were re-laid, copper bonds having been inserted at the joints. A description of the special form of joint now being used on the 80lb. rails in Phillip and Elizabeth Streets was read before this section by Mr. Cowdery last session.

Several new railways have been completed during the past year, mostly of the light type introduced by the Engineer-in-Chief, but I will only refer to a few of the works in connection with the railways that have come under my notice.

The accommodation of the public has been greatly improved by the construction at Eveleigh of the corridor cars now running on the Melbourne express. Mr. Thow has shown that work equal to that turned out by the celebrated Pullman Company can be made here, and by the provision of second-class lavatory cars, which commenced running a year ago, a very necessary benefit was conferred upon what is really the largest number of passengers.

The compound locomotives have not proved so economical on the N.S.W. Railways as they have in some other countries. This arises, I believe, not from any defect in the principle, but from the alternate ascending and descending grades, and they are now being converted into simple engines, as the slight saving in fuel did not compensate for the smaller load that they drew. Some very large engines designed by Mr. Thow are now at work on the

Digitized by Google

railway. The engine and tender when in running order weigh 106 tons 15 cwts.; the cylinders are 21 inches diameter by 26 inches stroke, and are, I believe, as powerful as any locomotives in the world. These engines can haul 207 tons up a grade of 1 in 30, or 315 tons up 1 in 40. The load hauled by the most powerful engines in 1888 was only 144 tons up 1 in 30 and 198 tons up 1 in 40, an increase of about 50 per cent. in favour of the latest type.

Some important works have been carried out by the Permanent Way department of the railway during the past year, the new bridge over Iron Bark Creek on the Northern line being one of them. The old bridge of timber consisted of 3 spans of 24 feet, each of compound girders resting on piles, and being in tidal water was completely destroyed by the teredo. Three new bridges having been built since the railway was first made, it was decided to replace the timber structure by one of steel resting on concrete foundations, and as this had to be done without interfering with the traffic, some difficulty was experienced in carrying out the work. The total length of the bridge is 110 feet, and the weight 103 tons. Owing to the depth of cross girders necessary to carry a double line of road, the rails were raised 3ft. 6in. above the level of the old bridge. The embankment on each side of the bridge had to be raised for a considerable distance, and to a large extent this could only be carried out at the same time as the bridge was being fixed. The superstructure was built on a temporary staging alongside the old bridge, and on the day previous to fixing in position it was lifted on to small trucks near the ends of the main girders, rails were laid across the line, and by means of four ship-jacks the whole bridge was pushed over and placed in position over the bed plates; it was then lowered into place. The actual time of travelling the span and lowering on to the bed plate was 1½ hours.

The work of replacing the timber viaduct at Wagga was fully described in a paper by Mr. Shellshear, read before the Australasian Association for the Advancement of Science. The original viaducts consisted of 317 spans of compound timber girders on

Digitized by Google

timber piles, each span being 29ft. 6in. in length; they are now being replaced by steel trestles on concrete foundations, and steel plate girders under each rail. Viaducts 3 and 4, consisting of 76 spans and 500 tons of steel, have been completed, and the foundations for a large portion of No. 2 are also finished; these have been put in place without in any way interfering with the ordinary traffic.

Considerable progress has been made in reducing the heavy gradients on the western and southern lines from 1 in 40 to 1 in 75 or 1 in 80, the expenditure for the past year being about £100,000, and the increased loading thereby equals on an average about 75 per cent., which shows that the money laid out is a good investment.

The harbour works referred to by Mr. Burge last year are still in progress under the direction of that branch of the Public Works Department. In Sydney itself, two new bridges, viz., Glebe Island and Pyrmont bridges, are to be built and the contract has been let for duplicating the 6ft. pipe conveying the water from the pipe head to Potts Hill Reservoir.

The large 18-million gallon service reservoir at Centennial Park, into which water will be pumped from Crown-street, has several features in its construction which are worthy of our attention, the large use of ashes for the concrete of the groined arches forming the roof being, I believe, new for such a large structure.

I am not able to record the initiation of any large works of irrigation, the work of that department having been mostly confined to the collection of information of a valuable character for the formulation of future schemes. The report of Colonel Home on this subject is mostly a confirmation of the schemes recommended by the engineer to the department, but it does not appear from a careful perusal of it that he considers that any large scheme will be a financial success for many years to come, the flow of the rivers being at times too small to allow of any water being taken from them for the supply of irrigation canals, so that the water in times of excessive flow would have to be stored to make up the deficiency.

Digitized by Google

A review of the engineering works of the past year would be incomplete without reference to the work of the Telegraph Department, for, although none of the works may be of the highest magnitude, yet in the aggregate they present a large total. For instance, since May 1st, 1896, 4000 telephones have been fixed, and although we have not yet the advantage of the metallic return, the Engineer-in-Chief for Telegraphs has made arrangements in the new Telephone Switch Board, for which the contract has been let, for the adoption of that system. The work would no doubt have to be done gradually, and would take time, but it is satisfactory to know that this much-needed improvement is contemplated.

The completion of the tunnels for telephone wires in the city has done much to improve the appearance of the streets, by permitting the removal of many of the unsightly poles and overhead wires. These tunnels are of an aggregate length of three miles, and cost £43,000 to construct. Where the tunnels have not been constructed the wires are in many places being laid in wrought-iron pipes under the footpath.

The construction of a telephone wire to Newcastle has been successfully completed. The distance is 104 miles, a copper closed circuit being used; and a line to Bathurst, 125 miles long, is now in hand. Although these appear long distances to speak over, yet they are trifles when compared with what is done in other portions of the world, and even in this colony I am informed that conversation is carried on through 206 miles of uninsulated wire, forming one of the wires of the fences connecting Wonnaminta with two other stations belonging to the Australian Mortgage Land and Finance Company in the Wilcannia district.

I have not much to call your attention to in reference to Mining, except to mention the application of the Cyanide Process for the extraction of gold from old tailings. One of the largest plants in this colony is at Mitchell's Creek, where about £2,000 has been spent upon it. They have there a heap of old

Digitized by Google

tailings estimated to contain 18,000 tons, each ton averaging 8 dwts. 4 grs. of gold, of which 75 per cent. is recovered; the cost of treating it amounted to about 13s. 6d. per ton, of which probably 3s. or 4s. is due to the presence of a little copper in the tailings. The shafts at Balmain for the Sydney Harbour collieries are now being sunk; the ultimate depth will be about 2,800 feet. Although this is deep for a coal mine, yet it has been exceeded in many places, the depth of the deepest coal mine in England being 3,474 feet, and a colliery in Belgium has a shaft 3,937 feet deep.

The development of artesian boring during the last ten years has done much to alleviate in some districts the distress caused by absence of water from other sources. From a return issued by the Hydraulic Engineer for Queensland, it appears that up to the end of June, 1897, bores of an aggregate depth of 110 miles had been sunk in Queensland in search of artesian water; the average depth per bore being 1,084 feet, the greatest depth that had at that date been attained in any bore in Australia being at Bimerah, in Queensland, where a depth of over 5,000 feet has been reached. In that colony there were at that date 349 bores delivering water above the surface, the estimated daily flow being 190,000,000 gallons. At some of these the flow has only been estimated, so, making a reduction of 50 per cent. from the returns furnished where estimates and not actual measured quantities are given, there is a daily flow of 131,000,000 gallons, or more than seven times the average daily supply of water to Sydney. Many of these bores deliver water under considerable pressure, and at Thargomindah the flow from the bore has been utilized for driving a dynamo for electric lighting purposes In this colony I find from a return furnished me by Mr. J. W. Boultbee that there are 99 flowing bores in addition to a number which yield supplies by pumping. The daily flow from these 99 bores amounts to about 62,000,000 gallons; the total depth bored being 154,173 feet, an average of about 1,600 feet per bore. There are a number of pumping bores, and a few of the bores sunk have proved failures.

Digitized by Google

There are very few bores in Victoria, the geological formation of the country being apparently unfavourable. In South Australia a number of bores have been sunk, in all 55, of a total depth of about 7 miles, and an average of 681 feet. In Western Australia a depth of about 4,000 feet has been bored to the end of June 1897, divided over ten bores, two of which were failures and four in progress, the flow from five of them totalling 967,000 gallons per day. In the United States, the practice of well-boring has been largely devoloped; bores are sunk not only for irrigation purposes, but so that the energy in the water flowing at a pressure can be utilised for providing power. A few examples of what has been done, taken from the report of the State of Dakota, issued in 1893, on "Artesian Water Supply and Irrigation" may be interesting; for instance, a flow of 1,000 imperial gallons per minute, issuing from a bore which showed a gauge pressure of 154lbs. when shut off, was used instead of a 25 h.p. engine to drive a 25-barrel flour mill. In another case, a flow of about 1,900 imperial gallons per minute, with a pressure of 165lbs., is reported to develop 100 h.p.; and in another case a flow of 2,700 imperial gallons per minute, and pressure of 86lbs., was sufficient to drive a 100-barrel flour mill. These examples could be multiplied if necessary, but I have given enough to show what is done in other places. There is, however, one other place I should mention, and that is the city of Waco, U.S.A., where 11 bores have been sunk entirely for the supply of power; the daily flow being 7½ million gallons, with an average pressure of 60 lbs., the power developed from these bores being used for many small industries.

I have mentioned these facts concerning American bores so as to bring more forcibly before you the great waste of power that takes place in N.S.W. owing to the neglect to utilise this energy, for there are bores in this colony which, Mr. Boultbee informs me, have pressures, when closed, ranging as high as 187lbs. Mr. J. B. Henderson, M. Inst., C.E., Hydraulic Engineer for Queensland, has, in the report previously referred to, proposed

Digitized by Google

an empirical formula for ascertaining the power that can be obtained from a flowing bore when the quantity of water discharged, and the pressure in the bore when the flow is stopped quickly are known. The results mentioned as obtained in America, as a rule, show that more power is obtained than Mr. Henderson's formula would indicate, but it may be that different geological surroundings affect the case, for he adduces the case of the Winton bore, where, according to the formula, 13·5 h.p. should have been obtained, and the experimental determination gave 13·96 h.p., showing that the formula closely coincides with the results obtained. Applying Mr. Henderson's formula to some of the bores in this colony, I find that in one instance the potential energy is capable of developing 84 h.p.; even allowing a large margin for overstatement of the flow, it may be safely assumed that 50 h.p. could be continuously developed day and night; and from two other bores, where I understand the flow has been gauged with some accuracy, more than 20 h.p. can be obtained in each case; these three bores are not far from townships. Many of the other bores are capable of providing from 5 to 16 h.p.

Professor Unwin in his lectures on the "Transmission of Power," delivered before the Society of Arts in 1893, estimated the cost of producing 10 h.p. in a small engine working for 1000 hours per year as £114, or if working 3000 per year as £207, so that if only 10 h.p. can be utilized for 6000 hours a year by some method of storage, either compressed air or electricity, the value would be nearly £400 a year. I believe it can be safely assumed that the flow from an existing bore is not likely to be prejudicially affected by another one in its immediate neighborhood, so that for the production of power, bores could probably be put down in a locality having a good flow and a pressure sufficient to warrant the expectation that the required power could be developed.

The difficulty of storing and transmitting this power would probably be best met by means of compressed air transmission,

Digitized by Google

especially on stations, as a very slight alteration to existing steam engines would allow of them being driven by air instead of steam, the air can also be used for driving direct acting pumps for irrigation or other purposes.

The irrigation settlement at the Pera bore is, I am informed, progressing satisfactorily, the proximity to a market is no doubt a large factor in its success, and arrangements are now being made to use the power from the bore now going to waste for driving the machinery required by the settlement.

Before leaving the question of artesian bores I would like to call your attention to the following remarks in Colonel Home's report on "Irrigation," in which he refers to bores: "As a rule, sufficient attention had not been paid to the selection of a site, the ground at the bore being frequently much lower than the adjacent ground or than the general level of the country which might be served by the water, and the difficulty and expense of taking the water about was much enhanced in consequence." The above quotation, I think, shows, that had the advice of an engineer been obtained by the proprietor of the bore before it was sunk the saving would have paid many times over for the fees he would have charged.

This subject is a large one and will well repay investigation, and now that so many bores have been sunk it certainly appears advisable that accurate gaugings should be made of the flow and pressure; in Queensland the Government have taken the matter up, and I understand that the attention of the Minister of Mines has been drawn to the necessity of similar investigations being made in this colony; if a commission were appointed to inquire into the question it would probably be able to establish with a close approximation to truth the hydraulic gradients of different lines of country, and also probably elucidate many of the questions which appear to be uncertain in connection with Artesian Boring.

In industrial developments New South Wales has not lagged behind the other colonies, in fact it is, I believe, in the front;

Digitized by Google

the construction of steel works for the production of the rails, bars and plates used here from local ores, which at one time seemed probable, has, for the present, apparently been dropped. New industries have started which it is to be hoped will flourish and be followed, as the demand increases, by the investment of more capital, amongst these may be mentioned the works for the production of anhydrous ammonia from gas liquor. These works have been constructed on the model of American works and are fitted with the best plant available; they are a means of working up a bye product from the manufacture of gas into a valuable agent used in many refrigerating machines.

The low rate of ocean freights and facilities for communication tend to place all countries on a level, and if we aspire to be a manufacturing country, or an exporting country, we must be prepared to sell as good or a better article than others at the lowest price; to enable that to be done it is necessary that there shall be no waste product unutilized, for it is out of these bye-products that the profit is generally made.

A useful illustration of the saving of waste products is to be found in the sugar refining business. To whiten the sugar, filtration through bone charcoal is necessary, and when making the charcoal by the distillation of the bones a large supply of lighting gas is obtained, while the ammonia is fixed by passing the gas through sulphuric acid, and sulphate of ammonia is thus made. Then the dust removed from the charcoal is worked up into boot blacking, and the charcoal when spent is turned into superphosphate by mixing it with sulphuric acid, the bones thus producing material for four trades, sugar refining, acid making, blacking manufacture, and agriculture.

In the manufacture of sugar the only waste product is molasses (of which the mill-owner seeks to produce as little as possible), for the crushed cane all goes direct to the boiler fires, as it has about one-fourth or one-fifth of the calorific power of coal. A small part of the molasses made in Australia is used for distilling, but this trade is of little value, as the spirit has to be

Digitized by Google

sold against that produced in Germany, on which a considerable export bounty is paid. Attention has, of late, however, been directed to the value of molasses as a food for stock, and I am informed that it is being largely used in the tropics as a substitute for grain in feeding draught horses, while a demand for it is setting in for giving a relish to the dry fodder on which sheep are unfortunately only being kept alive in a large part of New South Wales at the present time. Arrangements are also being made for burning this molasses in special furnaces to secure the large percentage of potash which it contains, and there is thus a prospect of its value being increased. It is, however, in the diminutions of the waste sugar in the manufacture and in the increase in the capacity of the factories that a great advance has been made of recent years. I understand that since the Sugar Company adopted the system of chemical check on this work the waste of sugar which takes place in extracting it from the cane has been reduced by more than two-thirds, while the working capacity of the factories has been raised by probably fifty per cent.; these improvements being forced on manufacturers here as in Germany by the extraordinary and continuous fall in the value of this product, which has amounted to about £15 a ton in the last fifteen years. There has been no change of importance in the rates of wages to produce this effect, but it has been brought about by the application of brains, so as to obtain the maximum yield from the manual labour employed, by improving the arrangements of the factories and the condition under which the work was carried on. Indeed the only change of importance in the plant has been the tendency to increase the number of times that the steam is required to do evaporation duty from three to four, and even five, with a consequent material saving in fuel.

Another illustration can be found in the meat export trade. About thirty years ago the hides and tallow were all that were obtained from the surplus cattle and sheep, the advance was then made by turning some of it into canned meat and some into extract of meat, still leaving a large amount of waste product; now

Digitized by Google

there is no need for any portion of the animal except that present as water to be wasted, the good meat is frozen and exported, tallow is of course obtained from other portions, and what was a few years ago considered as a nuisance and a source of expense to get rid of, viz., the blood, offal, and the liquid resulting from the operation of making tallow, have now been turned to profitable uses.

There is yet another waste of which I may say something, and this is the waste of skilled and unskilled labour. So far as can now be seen it appears probable that work of all sorts will be done here more on the American than on the European system, that is to say, by the employment of intelligent men at good rates of pay, and it will be well, therefore, to avoid as far as possible, the adoption of English trade practices quite unsuited to the system under which our factories will be run.

The recent Engineers' strike in England, which was virtually a strike for and a lock-out against the perpetuation of a waste of skilled labour, will serve as an example of the extreme cost and difficulty of effecting changes in wasteful methods of work, and how impossible it will be for us, with dear labour and short hours, to produce engineering work at a reasonable cost, if we keep a skilled mechanic looking at an automatic tool, or refuse to permit another, who can attend to two lathes without difficulty, to attend to more than one, even when he is anxious to take the two for a small allowance on the wages he is receiving.

The waste of life through bad or insufficient water supply or bad drainage is one of those preventible wastes which it is the duty of all Governments to do their utmost to reduce to the smallest limits. What the value of a man's life is to the State in money I am unable to say, but it must be great, and when the cost of carrying out necessary sanitary works are considered by Councils and local authorities, it is to be feared that very little regard is paid to that aspect of the case.

Digitized by Google

The great reduction in the death rate in the City of Sydney and the suburbs, due to improved sanitation, from 18·9 per thousand in 1888 to 13·4 per thousand in 1896 means the saving of 2,200 lives annually. The reduction of the rate in what may be termed preventible diseases has been much greater, for, taking the five years 1884 to 1888 inclusive, and comparing them with the five years ending 1896, the death rate from typhoid was only one-third of that of the former period.

I might go on for a long time instancing the savings in cost of manufacture or in preventing loss of life that arise from a proper scientific knowledge, whether it is the knowledge of the Chemist, or Doctor, or the Engineer, but I have taken up too much of your time already with a very rambling address, and must leave unsaid much that I had intended to bring before your notice, and have now only to thank you for your kind attention.

Digitized by Google

THE NARROW GAUGE AS APPLIED TO BRANCH RAILWAYS IN NEW SOUTH WALES.

By C. O. BURGE, M. Inst. C. E.

[*Read before the Engineering Section of the Royal Society of N. S. Wales, June 15, 1898.*]

ON December 21st, 1892, the writer read a paper (Vol. XXVII, Journal Royal Society, N.S.W.), on "Light Railways for New South Wales," and in this, and in the discussion it evoked, there were four considerations mentioned as objections to break of gauge at branches, viz. :—

1. Transhipment, and demurrage caused thereby.
2. Closing the branch as an asylum for old rolling stock.
3. Inability to draw upon the general system for extra rolling stock, to suit occasional excess of traffic, and hence the necessity of providing otherwise useless reserves.
4. Isolation as regards repairs to engines and vehicles.

It is now proposed to consider the applicability of a narrow gauge to the character of the goods and passenger traffic, to be dealt with, in this colony, by branch lines, independently of the question of the break.

This gauge question should be approached, not from the standpoint of those who, on the one hand, consider the question settled, from the fact of many important colonies and countries having, with their own requirements in view, adopted a particular gauge, or of those who are interested, financially, in narrow gauge material; nor, on the other hand, of those holding that worst phase of conservatism, which thinks that what it has been accustomed to see working successfully in the past, must necessarily be the best in the future. It should be considered rather by the more cold-blooded method of figures, used by those who have had experience in both systems, and in the application of such figures to the particular case under view. Much of the evidence given before the Victorian Committee on this subject

Digitized by Google

in 1895, was not of this latter character, and, judging from the result, it would appear as if the number of the witnesses, rather than their weight, from the uninterested expert point of view, was taken into consideration.

The great advantages to be gained by the adoption of a narrow gauge, apart from the question as to whether working expenses will be decreased or otherwise, are, firstly, its greatly cheaper first cost, and, secondly, its facilities for the further connection of the branch line with farm studs and wool sheds, etc., the sidings being easily laid through streets and round corners, and the road being readily removable to different points as required. No doubt, in many cases, these advantages obviate transhipment, now unavoidable at one end of a branch, if causing it at another. Hence, it is fairly obvious that if there be a break at all, the disadvantages of which are equal, no matter what gauge is employed, it is better to adopt the smallest gauge which has, by large experience elsewhere, proved to be at all practicable, and thus get the advantage of the cheapest construction, and, at the same time, the most manageable system for sidings to farms, etc. For this reason it is proposed to consider the effects to the working caused by 2ft. gauge branches, and, as it is agreed that the smallness of the traffic is the main argument for the smaller line, the matter will be considered in connection with as small a traffic as would justify, according to present criteria, the construction of a line at all.

It is commonly and truly said, by the advocates of narrow gauge lines, that the proportion between the weight of their trucks and that of the maximum load which *can* be carried is much larger than in the case of the wider gauges; for instance, the ordinary 2ft. bogie truck weighs only 2·70 tons and can carry 10 tons, or a proportion of 1 to 3·70, while the newest and best proportioned similar one on the New South Wales lines weighs 10 tons and can carry only 22 tons, or a proportion of 1 to 2·20.

The reason for this is obvious. If the waggons were stationary, and had merely to carry their load at rest, their strength, and therefore their weight, might be proportional to the load, but

Digitized by Google

when momentum, due to the combined greater speed and weight, as well as the greater inertia of the heavier stock in shunting, has to be considered, it is easily seen that the necessary strength, and therefore weight, of the waggon must increase in a much greater ratio than the weight of the load which it has to bear. *If*, therefore, a maximum load, in each case, could always be ensured, the advantage, as regards lesser proportion of non-paying or dead load, would largely lie with the 2ft. gauge. But there is a marvellous quantity of virtue in this particular "if," especially in the particular case before us, a qualification of the principle not often enough brought forward when this supposed superiority of the narrower gauges is urged; for maximum loading is quite exceptional; such, for instance, as exists in the heavy slate carrying business of the Festiniog 2ft. line in Wales, the case of which, therefore, should never be quoted, as it often is, as an example for other projects under altogether different, conditions. The ore carrying 2ft. Zeehan line in Tasmania, which has been recently put before us as a pattern, has a traffic of a similar character.

There are two points to be considered in measuring the capacity of a truck, weight carrying capability, and space. If we are called upon to carry a load of pig lead, for instance, the space available is evidently excessive in either small or large trucks, and as the maximum weight can be carried in either, owing to low centre of gravity, the dead load is proportionately much smaller in the smaller gauge, and still more so if the conditions of the traffic necessitate the waggons returning empty, or nearly so.

If, however, we have hay or straw to carry, we can load up in the large truck, without unduly raising the centre of gravity, about a third of the weight capable of being carried by it, but in the 2ft. gauge truck we are obliged to stop at about 5ft. 6in. over the floor, to avoid having the centre of gravity of truck and load, too high for stability, this height being little more than the sixth part of the height which the weight carrying capacity would allow. Again, as to the loading of sheep, regard must be had to overcrowding, so that this is a light load for the space

Digitized by Google

which it takes up, and the two loaded tiers of the standard gauge truck is impracticable on the 2ft., owing to that, also, throwing the centre of gravity too high; while to gain sufficient height for cattle, the floor of the 2ft. cattle truck has to be lowered between the bogies, the space over which is wasted. Hence a greater proportion of dead weight is necessary than in the larger 4ft. 8½in. vans.

If we except coal and firewood, which are nearly all confined to the main lines of New South Wales, which latter, being already made, are necessarily excluded from our comparison, it will be found from the Railway Commissioners' reports that the bulk of the remaining up traffic, which we may fairly assume as generally applicable, as an all round average, to extensions, is divided, as to weight, in the following approximate proportion, viz. :—

Grain	..	42%	This loading occupying about	50	cubic ft.	of space	per ton
Hay, Straw, &c.		14	,, ,, ,,	300	,,	,,	
Wool	..	17	,, ,, ,,	150	,,	,,	
Cattle	..	14	,, ,, ,,	162	,,	,,	
Sheep, &c.	..	13	,, ,, ,,	406	,,	,,	
		100	Average =	164	cubic feet	per ton.	

The down traffic will be considered later.

As goods occupying about 93 cubic feet to the ton, form the load in which the loading space, 2,040 cubic feet, of the standard gauge bogie goods waggon is fully utilized it is evident that there is an unavoidable waste of weight carrying capacity for all the above loading, except, in the case of grain, and still more must this be the case as the gauge decreases, for the cubical capacity is limited in both cases, but more frequently in the narrow gauge, as regards some classes of loading, by the height of the centre of gravity of the waggon and its load. This height is taken, as a maximum, at about 6 feet over rail for the standard gauge, and, proportionately, 2ft. 8in. for the 2ft. gauge, though this unduly favours the latter, as, owing to the greater lateral overhang, the danger of lateral displacement of the centre of gravity, through careless loading, is greater.

Digitized by Google

The maximum loading space of the similar 2 feet waggon is 600 cubic feet, and its maximum weight carrying capacity is 10 tons.

Working out the proportions between the live and dead load (waggons only) for the two gauges, we find them to be as under, bearing in mind that we are now dealing with up traffic only :—

Proport'nate Weight of each.		Standard Gauge.		2-foot Gauge.	
		Live Load.	Dead Load.	Live Load.	Dead Load.
42 %	Grain	1·00	0·46	1·00	0·38
14 ,,	Hay, &c.	1·00	1·50	1·00	1·57
17 ,,	Wool	1·00	0·63	1·00	1·00
14 ,,	Cattle (Standard Gauge 4-wheel Trucks)	1·00	1·20	1·00	2·00
13 ,,	Sheep (Standard Gauge 4-wheel Trucks)	1·00	2·90	1·00	4·00
100%					
Average, having regard to proportion of each class of loading.		= 1·00 ..	1·06	1·00 .	1·35

We shall illustrate this now by an example. Assuming one standard gauge train on a branch line, with a nett or paying load of 100 tons, made up in the proportions previously given, viz., 42 tons of grain, 14 tons of hay, and 17 tons of wool, 14 tons of cattle, and 13 tons of sheep. Taking the dead loads corresponding to these, as above, we get 19 tons of truck weight for the grain, and 21 tons, 11 tons, 17 tons, and 38 tons respectively for the rest, summing up to 100 tons for the load, and 106 tons for the waggons, total 206 tons. The railway reports show that the back or return loading in N.S.W. is, roughly, about $\frac{1}{5}$ of the weight of the up loading, so that the average for the double journey would be $\frac{100 + 20}{2}$ = 60 tons live load, and 106 tons dead.

Suppose, now, for the branch, we take an average traffic of 6 trains per week, each way. It is true that as small a traffic as is represented by half that running, exists on some lines which have been constructed, but either these have been mistakes, or they run through, as yet, undeveloped districts, with which our

Digitized by Google

comparison has nothing to do, dealing, as we are, with the permanent requirements of the future.

This traffic represents, therefore, 624 train miles, per mile per annum, with an average gross load, behind engine, of 166 tons, equal to 103,584 tons gross annually, of which 66,144 tons is dead, and 37,440 tons live load.

As to the comparative cost of this service, on lines of each gauge, we may omit, as independent of gauge, the general charges and the traffic department expenses, which vary with the volume of traffic, more than with the number of trains in which it is carried. The maintenance and locomotive expenses, in N.S.W., in 1896-97, were about 32d. per train mile. Hence the cost of working the above traffic, as regards these two departments on the standard gauge, would be, annually, per mile,

$$624 \text{ train miles} \times 32\text{d.} = £83\ 4\text{s.}$$

Now let us see how this same volume of traffic would be conducted by a 2 feet line.

Taking the up journey first, we have 31,200 tons to be conveyed annually, and for the dead load, each 100 tons has to be subdivided, according to the proportions already given, into $42 \times 0{\cdot}38$, $14 \times 1{\cdot}57$, $17 \times 1{\cdot}00$, $14 \times 2{\cdot}00$ and $13 \times 4{\cdot}00$, so that for each 100 tons of goods, 134·94 tons of waggons will be required, equal to a total of 42,101 tons dead up loading. Then taking $\frac{1}{5}$, as before, of the live up load, 31,200 tons for the down traffic, equal to 6,240 tons, we get, as the mean live loading annually, $\frac{31,200 + 6,240}{2} = 18,720$ tons, and 42,101 tons dead load equals 60,821 tons gross.

The comparison between the hauling capacity of an ordinary branch standard gauge engine, as regards load behind it, with a first-class 2 feet engine, *ceteris paribus*, except as to speed, which will be referred to later, is about 3 to 1, therefore, if the average of 166 tons gross load be assigned to the former, 55 tons will be that of the latter, and $\frac{60,821}{55}$ tons = 1106 train miles will be

Digitized by Google

required to do the same work as the 624 train miles of the larger gauge. But this is assuming that each is travelling at the same speed. On reference to the experience of working of existing 2 feet lines, the ordinary most economical speed of the train might be taken at about one half of the standard gauge economical speed, so that the train mileage, 1,106, must be doubled in order that the same work may be done; hence, if the length were indefinite, 2,212 train miles of the 2 feet train would be required to do the work of the 624 train miles of the 4 feet 8½ inch. line, but this would be only, strictly speaking, correct where the length of the branch is sufficient to utilize the speed of the standard gauge train. If a branch line, for instance, with such a traffic as we have been dealing with, is too short for a standard gauge train to be fully occupied by one journey each way, travelling at its most economical speed, and including shunting, it is evident that credit cannot be taken for its full double capacity of speed, which has not been required to be used, while the speed of the corresponding number of slower 2ft. trains might be sufficient for the same duty, on such a short length. As some such short lines might be necessary, without prospect of extension in the future, it would be safer to take the general average of 2ft. train mileage at three times that of the standard gauge for the same duty, say 1,872 train miles.

We have not much information with regard to the locomotive and maintenance expenses per train mile of 2ft. gauge lines. In Mackay's book on "Light Railways" he gives 13d. as the average of the four English lines on this gauge, including the old established Festiniog railway, on which it is about 12d. That of French 2ft. lines is 11d., and the Prussian lines somewhat less. These items, loco. and maintenance charges, on the standard gauge lines in Australia, are over 75 per cent. greater than the corresponding English standard gauge rates, owing to higher wages, &c., and, as we may fairly suppose the same ratio to exist in the case of the smaller line, 22d may be safely taken, as an average, here for the 2ft. gauge similar expenses. Hence the cost of working,

Digitized by Google

as regards these two departments, would be per mile, per annum:

2ft. gauge 1872 train miles × 22d. = ...	£171	12	0
Standard gauge 624 train miles × 32d., as before = ..	83	4	0
Difference in favour of standard gauge per mile per annum	£88	6	0

Though written a quarter of a century ago, the following extract from a report of the Consulting Engineer to a main 5ft 6in. gauge Indian railway, when it was proposed to introduce a narrower gauge, may be quoted as bearing, *mutatis mutandis*, on this question.

The existing gauge was fixed under Lord Dalhousie's administration, after a most careful consideration of the relative bulk and weight of each of the characteristic classes of Indian produce which must be conveyed along the lines of railway. From the record of two years' traffic carried over the Bombay, Baroda, and Central Indian Railway, in 1870 and 1871, consisting of forty-three classes of goods, of each of which the proximate specific gravity was given, they found the range to be, for Indian produce, from 224 cubic feet of bulk per ton of weight to 5 cubic feet of bulk per ton of weight; and that the averages of the two years' traffic were 75 cubic feet per ton in 1870, and 78 cubic feet per ton in 1871, which, making a slight allowance for waste in waggon stowage might be taken at a general average of 80 cubic feet per ton. This would give an average space of 640 cubic feet for the stowage of eight tons in the ordinary waggon on the 5½ft. gauge, the height of the load above the platform not exceeding 5ft. and the centre of gravity of the gross load not exceeding 5ft. above the rails.

He admitted the fitness of a narrow gauge waggon in a Welsh mining district, running with its eight ton load of minerals down an incline to the nearest port, or to a station on the general railway line, each ton measuring from 5 to 12 cubic feet, and the entire load being contained within 100 cubic feet of waggon space. But how were they to pack their eight-ton load of half-pressed Indian cotton, measuring 1,488 cubic feet, or eight tons of Australian wool measuring 1,120 cubic feet? Were they to build it up to 20 feet or 30 feet high on a little waggon having only two or three feet transversely between the wheels, and, therefore, only one half of its proper stability?

The plea of economy has been advanced as the motive for making the proposed disastrous change. While the 3½ft. gauge might answer for the carriage of heavy minerals in special districts, the general commerce of every populous country mainly consisted of articles of low or medium specific

Digitized by Google

gravity, adapted to food, clothing, fuel, &c., averaging about 80 cubic feet per ton weight, for which the 5½ft. gauge was in every respect most suitable as regarded cost, stowage, safety, economy, the intricate elements of military defence, and the power of adopting single track lines of railway for the accommodation of a large amount of traffic.

The reason of the comparatively small excess of the running expenses per train mile of the standard, over those of the 2ft. gauge, 32d. as against 22d., is to be explained in this way :—As regards locomotive expenses, as many men are employed on the small train as on the large one, and, on account of the low speed, they are longer doing the same work, so that this, to some extent, compensates for the much lower fuel consumption, and repairs, per mile. The 2ft. maintenance of road expenses deal with a lighter permanent way, and lighter renewals, but *per contra*, the road has to be kept in much better order than the wider one, to ensure the same stability, with the greater lateral overhang of the smaller rolling stock.

Taking the 2ft. line with a small traffic, of the character mentioned, about £88 per mile would be the extra annual working charge, exclusive of that due to break of gauge. This, capitalized, say £2,500 per mile, is therefore the amount of saving in construction, which, owing alone to the unsuitability of the small gauge to the character of the traffic, must be exceeded to justify its adoption in country branches in N.S.W. Now, in the easier country of this colony, many of the recent standard gauge branches have already cost per mile, all told, if we except items unaffected by gauge, considerably less than this, so it is clearly impossible to save on them ; nor is it easy to conceive the possibility of saving this £2,500 per mile on any line except those of such magnitude, as regards works, as would put their construction, even on the small gauge, out of the question, to earn the moderate traffic which we are alone considering.

The almost chance adoption of what has been amply proved, since, to be the best gauge for their purposes, in England, the Continent of Europe generally, and America, on grounds which had been derived from little or no experience, is one of

Digitized by Google

the most curious facts in the history of mechanical science. Had the question been investigated at all, the comparatively high specific gravity of most of the goods loading to be expected in England, such as coal, iron, manufactured articles, and general merchandise, would have pointed to the adoption of a narrower gauge than the 4ft. 8½in., as has been shown, had there been nothing but dead weight to be thought of; but this would have been over-balanced by the necessity, then probably unforeseen, of high speed, which is only economically obtainable on the wider line—speed, which is not only now found to be indispensable for the large passenger traffic, and for special classes of goods, but also to enable the lines to be cleared of the enormous amount of general traffic which has to be dealt with in a limited space.

Goods traffic only has hitherto been considered, and in New South Wales this must over-ride, from its preponderance, any passenger question, but it will be found that the branch passenger service will suffer also by the adoption of a small gauge. It must be remembered that in France and Prussia, where the 2ft. lines are most prevalent, the passenger traffic is more important than the goods, and it is largely made up of farm people, attending markets at the numerous and contiguous villages of thickly populated agricultural districts, to which there is no parallel in Australia. In the districts accommodated by these European branches, the average passenger journey would be probably only 4 or 5 miles in length; then on account of the expense of horse-keeping there is no other alternative between travelling by rail, or on foot, with the great majority, and even a speed of 9 miles per hour is a consideration. Far different are the colonial conditions, every small farmer has his horse and trap, and owing to cheap horse flesh and feed, few, indeed, are without easy means of travelling by road. If, therefore, a passenger service of 9 miles per hour is offered to such a population, it is such a small improvement on its existing means, both as regards time and money, that, practically, the whole passenger traffic, on the 2ft. branches, would be lost, by the passengers driving themselves to the main line.

Digitized by Google

The greater part of the figures in this paper are necessarily approximate, and the various positions of the centre of gravity of truck and load, on which much of the argument depends, are practically incapable of exact determination, so that to cover inaccuracies, a very decided advantage for one system over the other, in the particular cases dealt with, must be made out. This has been done, and the margin is so great for possible overstatement, as regards the important matters of the amount of the different classes of loading, and of the relative cost of working on the two gauges, that the conclusion to which the figures and the facts of this paper, as well as those of the previous one, point, is that a certain combination of circumstances must exist, to justify the construction of branch railways in New South Wales, on a smaller gauge than that of the present lines.

These circumstances are, firstly, that the district to be served must consist of rough country, in order that the economy of narrow gauge construction may be sufficiently felt to influence the choice, and hence a fairly large traffic must exist to pay interest on heavy construction; secondly, that such district be large enough to contain and require a narrow gauge system, considerable enough in itself, to minimise the evils of isolation; and, thirdly, a preponderance of traffic of high specific gravity, such as slate, coal, or ore, must be obtained, with an absence of dependence for profits on passenger or live stock traffic.

It will be found that such a combination does not exist in New South Wales, and hence it is good policy not to depart from the existing gauge, but to seek economy in construction by other means, according to the nature of each particular case, such as sharper curvature, steeper grading, and care in alignment and in design, in which latter, utility should be the sole guide.

Digitized by Google

ENGINEERING CONSTRUCTION IN CONNECTION WITH RAINFALL.

By J. I. HAYCROFT, M. Inst. C.E.I., Assoc. M. Am. Soc. C. E., Assoc. M. Can. Soc. C.E., M.M. and C.E.

[*Read before the Engineering Section of the Royal Society of N. S. Wales, June 15, 1898.*]

IT is proposed to divide the subject into three parts, firstly, as applied to Road or Railway Engineering; secondly, City or Municipal Engineering; thirdly, Water Conservation. The latter, however, will be dealt with only sufficiently to show in what respect its consideration differs from that of the other divisions.

The manner in which rainfall affects the railway engineer renders this branch of our profession the most liable to censure on the part of the general public. This has been the rule, and probably always will be, until either the law regulating rainfall, if such exists, be understood, or engineers be entrusted with sufficient capital to build absolutely safe structures; then, if qualified men are employed as engineers, the world will cease to hear of loss of life and property due to bad design in providing insufficient waterways under or in place of banks.

The Engineer who is called on to lay out a railway in settled country, such as the United Kingdom or the Continent of Europe, where maps showing the natural features of the country exist, is much more favorably situated than one who has to explore the country before even laying down a trial line, such as is the case in parts of America and Australasia. The latter is also naturally ignorant of a most important factor necessary to render his line a safe one, viz., the amount and duration of the maximum rainfall of the district through which the line is to run; he has, for instance, no reliable means of deciding the size of required culverts at any particular place. The possession in a settled country, of all necessary information, enables a line to be designed with regard to ultimate cost, more cheaply than where that information is wanting. The ultimate cost includes, not only the first cost of construction but such additional cost as arises subsequently from accidents happening after the line has been opened to traffic.

Digitized by Google

Author.	Formula.	Authority and Remarks.
Col. Dickens	$Q=825\ M^{\frac{3}{4}}=100\ CM^{\frac{3}{4}}$	Jackson's Hydraulic Manual
,,	$Q=27\ CM^{\frac{1}{2}}$	Fanning's Hydraulic Engineering C = 8·25
Ryves	$Q=CM^{\frac{1}{2}}$	Wilson's Irrigation Engineering C = 400 to 500 in flat country = 650 in hilly country with maximum rainfall
Fanning	$Q=200\ M^{\frac{5}{6}}$	Fanning's Hydraulic Engineering
C. O. Burge	$Q=\frac{1300\ M}{(\text{Length of Fetch})^{\frac{1}{2}}}$	Prof. Kernot, A.A.A. Science, 1888
Dredge	,, ,,	Fanning's Hydraulic Engineering
,,	,, ,,	Patton's Civil Engineering
Jackson	$=C\frac{\text{Breadth}}{\text{Length}}A^{\frac{1}{2}}$	Prof. Kernot, A.A.A. Science, 1888
Steane	$Q=\frac{181 \times \text{Area in sq. chains}}{1800\ (\text{Length in chains})^{1\cdot 2\,5}}$	Trans. Royal Soc., Victoria, 1887
Craig	$Q=440\ BN$ hyp. log. $\frac{8\ L^2}{B}$	Min. of Proc. Inst. C.E., Vol. 80 B = Width of Catchment in miles L = Length ,, ,, N = 1·16 ,, ,,
O'Connell	$Q=-45\cdot796+(2097\cdot28 \times 457\cdot96\ A)^{\frac{1}{2}}$	Patton's Civil Engineering
McComb	$Q=5\cdot29375\ A^{\frac{3}{4}}$	,, ,, ,,
Bürkli Ziegler	$Q=CRS^{\frac{1}{2}}\ A^{\frac{3}{4}}$	"Trautwine." S = Slope in feet per 1000. C = ·31 to ·75
McMath	$Q=CRS^{\frac{1}{5}}\ A^{\frac{4}{5}}$	Trans. Am. Soc. C.E., Vol. XVI.
,,	$Q=2\cdot488\ RS^{\frac{1}{5}}\ A^{\frac{4}{5}}$	Patton's Civil Engineering
Adams	$Q=ACR\left(\frac{S}{A^2R^2}\right)^{\frac{1}{12}}=CR^{\frac{5}{6}}A^{\frac{5}{6}}S^{\frac{1}{12}}$	,, ,, ,, C = 1·035 S = Sine of slope
Hawksley	$Q=ACR\left(\frac{S}{AR}\right)^{\frac{1}{2}}=CR^{\frac{3}{4}}\ A^{\frac{3}{4}}\ S^{\frac{1}{2}}$	Patton's Civil Engineering C = 3·946. S = Sine of slope
Chamier	$Q=ACR\left(\frac{M^{\frac{3}{4}}}{M}\right)=5\cdot03\ CRA^{\frac{3}{4}}$	Chamier
Prof. Kernot	$O=CM^{\frac{3}{4}}$	A.A.A. Science, 1888. C = 40 to 80
E. T. D. Myers	$O=CA^{\frac{1}{2}}$	Committee of Ass. Ry. Superintendents. C varies from 1 to 4
Prof. Talbot	$O=CA^{\frac{3}{4}}$	Committee of Ass. Ry. Superintendents. C from $\frac{1}{4}$ to 1
R. M. Peck	$O=\frac{A}{C}$	Committee of Ass. Ry. Superintendents. C from 4 to 6
Cleeman	$O=CA^{\frac{1}{2}}$	Proc. Inst. C.E., Vol. LVIII. C = 1 to 1·6
Steane	$O=A^{0\cdot62}$	Trans. Royal Soc., Victoria, 1887.

Q = Cubic feet per sec. from Catchment.
R = Rainfall in Inches per hour.
O = Area of Opening in Square Feet.
A = Area of Catchment in Acres.
M = ,, ,, Square Miles.
C = A constant depending on circumstances.

Digitized by Google

Many formulæ have been proposed from time to time to enable an engineer to deal intelligently with this subject, but no absolutely certain general rule has been, or, indeed, can be laid down on this point.

Appended is a list of various formulæ proposed for determining the discharge from any given area.*

	Bürkli Ziegler	Colonel Dickens	Colonel Ryves	Fanning	McComb	McMath	Adams	Hawksley	Cleeman	Myers	Talbot	Chamier
Acres.	Discharge in Cubic Feet per Second.											
5	7	22	25	3	17	7	5	9	22	22	4	16
10	12	36	41	6	30	11	9	15	32	32	7	28
15	16	49	53	9	40	16	11	20	39	39	10	38
20	**20**	61	67	11	50	**20**	17	25	45	45	12	47
30	27	82	85	17	68	27	22	34	55	55	16	63
40	34	103	102	20	84	34	28	42	63	63	20	78
50	40	121	119	24	99	41	33	**48**	71	71	24	93
60	45	139	134	28	114	48	39	54	77	77	27	106
70	51	156	149	32	128	54	45	61	84	84	31	119
80	56	173	162	35	141	60	50	67	89	89	34	132
90	62	189	176	38	154	66	56	74	95	95	37	144
100	67	204	191	43	167	72	62	80	**100**	**100**	40	156
150	90	277	247	60	226	99	84	108	123	123	54	211
200	112	344	299	76	281	125	106	134	141	141	67	262
250	133	406	347	92	332	149	129	160	158	158	80	309
300	152	465	392	107	380	173	151	182	173	173	91	355
350	171	522	434	121	427	195	168	205	187	187	102	398
400	189	577	475	136	472	217	190	227	200	200	113	440
450	206	631	514	150	515	239	207	247	212	212	124	481
500	223	683	551	163	558	260	230	268	224	224	134	520
1000	375	1149	**875**	291	**938**	452	409	450	316	316	225	**876**
1500	518	1587	1146	408	1296	625	571	622	387	387	310	1210
2000	631	**1931**	1389	518	1578	787	728	757	447	447	378	1472
3000	855	2617	1820	727	2138	1089	1019	1026	545	545	513	1996
4000	1061	3247	2205	924	2653	1371	1294	1273	632	632	637	2476
5000	1255	3839	2555	1112	3137	1639	1557	1506	707	707	753	2924
10,000	2110	6460	4061	1982	5275	2855	2872	2532	1000	1000	1266	4923

A review of these formulæ shows that widely different results may be arrived at by applying any two of them under like con-

*The author will feel much obliged for any other proposed formulæ, and for any expression of opinion as to its reliability or otherwise.

Digitized by Google

Digitized by Google

ditions, a fact that is well illustrated by the accompanying diagram. In many cases this is not to be wondered at, as some of these formulæ have been put forward as applicable only to particular districts. Take, for instance, that of Colonel Dickens, which was designed to deal with rainfall in different parts of India, and where the only quantity to be introduced, independently of judgment, is the area of the catchment; this item can be ascertained with very fair approximation, but no engineer worthy of the name would think of applying such a formula to a country like Australia, without having first determined the suitable constant to use in the particular case under consideration; these constants have a very wide range, reaching from the minimum 0·03, to a maximum of 24. The localities from which each were derived are given in Jackson's Hydraulic Manual, and his statement as regards the value of the constant is as follows: "It can be determined and made use of within local limits only, as it depends on an average maximum local downpour, evaporation, quality, inclination, and disposition of surface of the area under consideration: it has hitherto been determined for very few districts, and not sufficiently satisfactorily for some of them. In some cases unfortunately doubtful flood marks have been used to obtain the flood gradients, and the velocities calculated according to very varied formulæ. In others the obstructions caused by bridges and embankments have vitiated all the bases of the calculations of discharge."

After such an explanation, it is evident that before using this formula in Australia, it is necessary to prove that the conditions are identical. Where flood marks are observable, as in catchments discharging by streams with defined channels, no such formulæ need be applied, nor, indeed, are they necessary; if doubt exists as to the reliability of the marks, an experienced engineer can make requisite allowances.

On consideration of the most approved formulæ which include factors for absorption, rainfall, slope and area of catchment, it is at once evident that these can be applied only where these several factors are sensibly constant; this constancy cannot

Digitized by Google

exist in very large areas, when it is remembered that the slope, the absorbent nature of the ground, and the intensity of the rainfall, vary considerably, even in the radius of a few miles. Even in small areas the maximum rainfall, which is here being considered, is what may be termed "patchy," and, although the slope is ever varying, still its value may be approximated to within reasonable limits, by suitable observations, but certainly not by independent aneroid observations, a method which the author has known to be employed. On examination of the formulæ, it will be seen that nine of them are supposed to give a means of determining the number of cubic feet per second discharged from a catchment area, in terms of that area, its length in some cases, and length and breadth in others, combined with various constants, but no account is taken of amount of rainfall, nor of the varying slope of different catchments, so that, according to these formulæ, the same volume of water would have to be provided for, whether the ground was flat or hilly, or whether the rainfall was at the rate of one inch per hour, or twelve inches per hour. It is hardly necessary to state that such formulæ cannot possibly be reliable. On the other hand, it would not be just to say that therefore these formulæ are of no use; on the contrary, it is probable they are applicable to conditions identical with those whence they were derived. As, however, none of them have been designed for use in these colonies, they cannot be considered applicable to local conditions.

Six other formulæ give the area of opening required in square feet, in terms of a constant, and the area of the catchment. These also may be considered as of a specific nature, and not adapted to general use, with the exception of that of Professor Kernot, which has been shown to be applicable in portions of these colonies.

Five other formulæ give the discharge of the catchment in cubic feet per second, in terms of a suitable constant, determined by the nature of the surface of the catchment, the rainfall of the district, and the slope and area of the catchment, thus embracing all factors necessary to make them generally applicable.

Digitized by Google

It is noticeable how closely, for practical purposes, these formulæ agree, within such limits as they would probably be used.

Thus for a catchment of 100 acres, the run off is given as follows :—

Adams	...	62	cubic feet	per second.
Bürkli Ziegler	...	67	,,	,,
McMath	...	72	,,	,,
Hawksley	...	80	,,	,,

The consideration of the factors, used in these formulæ, will now be entered on. They are divided into four heads, viz :—

1. The rainfall.
2. The kind and condition of soil.
3. The area of the catchment.
4. The general character and condition of same.

The rainfall.—The maximum rainfall during the most severe rain storms is what is to be considered.

It will be generally conceded that rainfall of this description is limited in extent and of short duration, so that the size of the area must be considered. In the Southern portion of this colony a catchment of 10 acres might be subject to a rainfall at the rate of six inches per hour, but an adjoining catchment of, say, 500 acres would only be partly affected by this local intensity of rainfall.

There is considerable difficulty in dealing with this part of the subject in a general manner, since it hardly lends itself to such treatment ; each particular case must be dealt with on its merits. The only definite thing which may be predicated about each district is that it has its own peculiarities ; these must be thoroughly known and understood to enable the question to be treated intelligently.

The run off from a catchment, due to melting snow, is of the greatest importance in some districts. Its volume is always in excess of that caused by the maximum rainfall, but as its effects, in the shape of flood-marks, are invariably observable, the question of suitable formula need not be discussed here.

Digitized by Google

The kind and condition of soil is a most important factor in dealing with this subject. For example, during a period of wet weather of, say, four days' duration, and of varying intensity, the run off from a given area will vary considerably in the extreme cases of a porous area, such as a sandy surface, and an area consisting of a clay surface. In the first case the four days' rain may never sufficiently saturate the soil to permit any of the rain to flow off during that period in such quantity as to need any provision but the smallest culvert, although the flow may continue for some weeks after the rain has ceased, whilst in the case of a clay surface, even after a period of drought, the area may be rendered impermeable, after, say, one day's rain, so that all the fall for the following three days must be provided for, while a day or two after rain ceases the creek in which the run off took place would practically be dry again.

In this connection it may be said that maximum rainfalls should be considered as falling on impervious ground, inasmuch as such rainfalls frequently occur during a continuance of wet weather. The experience of the writer is that such heavy rain falls form climaxes to periods of wet weather, which, commencing moderately, proceed in intensity (not, it is true, in any fixed ratio), come to a head in a very severe rainfall of short duration, and then fall in intensity gradually, until rain ceases for that particular period.

Now, the difficulty with which an engineer has to contend is that rain gauges, except those automatically registering, show nothing but the gross amount of rainfall between the periods of observation. As, for instance, a rain gauge observed at stated intervals, say 24 hours, showing, perhaps, that during that period 8 inches of rain had fallen, does not indicate whether 7 inches of it fell in 23 hours and one inch during the balance, or *vice versa*. In such a case experience is of value in forming a correct judgment, and the most severe conclusion which may be drawn from observing such a gauge, guided, of course, by what has been learnt in regard to such rainfalls, either from recording gauges or from experience, will be the safest. The records of a self-

Digitized by Google

registering rain gauge, maintained for a number of years in a given catchment, are invaluable. Few catchments are thus equipped. In the absence of such a gauge the records of the nearest rain gauge, considered in relation to its proximity to the catchment and the physical geography of the locality, is the best substitute. In designing a means of egress for water from a catchment the maximum rainfall of the district is, of course, the chief consideration, but this must be considered in an intelligent manner.

Let a typical case be considered. Say there are two towns, X and Y, about 40 miles apart, lying between which is a range of fairly high hills, practically parallel to the bee-line between the towns. Now suppose, during a period of wet weather, a rain gauge at X registers at the rate of 2 inches per hour, and a gauge at Y at the rate of 6 inches per hour, an engineer, in providing outlets for catchments, embracing the range and sloping ground at its base, is bound to consider those various catchments as liable to be subject to the greater rainfall per hour. The rainfall should not be graded for the several catchments between X and Y, so that at a point midway between these towns a rainfall of only 4 inches per hour would be considered. Such a treatment would be very convenient if it was in accordance with natural law; but, unfortunately, such is not the case. On the other hand, the rainfall on the range would probably exceed the record of the gauges observed at its ends.

Nor, having fixed the probable maximum rainfall, as in this case at the rate of 6 inches per hour, is it permissible, because rainfall may take 6 hours to travel from the extreme point of a certain catchmennt to the outlet, to consider it as a rainfall at the rate of 1 inch per hour falling for 6 hours.

It is very important to consider only those catchments whose area permits them to be affected as regards maximum volume produced at their outlets by such rainfalls. An area whose extent renders it unlikely to be wholly affected with the maximum rainfall of the district, can still be considered as suitable for the application of some formula, by taking the conditions

Digitized by Google

as they occur in Nature—viz., the whole area affected by a rainfall of moderate intensity, during continuance of which occurs a maximum rainfall on portion of the area. Such cases occur, and are those which cause maximum volume at an outlet, and, therefore, are those to be provided for.

The area of the catchment.—This item, of great importance, can always be determined with a sufficient degree of approximation, either by marking the line of watershed on a reliable map, or, in the absence of such, making a rough traverse thereof. It has been already stated that all formulæ are limited to definite areas, but the determination of the extent of the maximum area to which a formula may be considered applicable is a very difficult matter. It has already been said that when the run-off from a catchment area takes place in a defined channel, formulæ are unnecessary. No definite rule applies as to when formulæ are to be put on one side, and flood-marks made use of.

In connection with the subject of flood-marks there are certain liabilities to error, to which attention may be drawn. Jackson's remarks have already been referred to, but the writer calls to mind a case in this colony where a catchment of nearly 50 square miles, with a well-defined creek as an outlet, was observed by him within six days of rain having fallen as absolutely dry, and this in a country where one day's steady rain would render the surface practically impermeable. Flood-marks were observable on the railway bank, through which the culvert forming the outlet for this area was constructed, but such marks were useless to determine the discharge from that area, even if the rainfall were known, as, if the line had not existed, their height would have probably not been within 18 feet of where they appeared to be. Observation of flood-marks, to be of practical use, should be taken at such points on a stream where the flood-waters are removed from any chance of being unduly raised, owing to obstructions, insufficiency of structure, or other causes having a like effect.

The longitudinal section in the case mentioned showed the inclination of the bed of the stream above the obstruction as

Digitized by Google

fairly inclined, whilst the surface of the water as determined by the flood-marks was nearly level. It is only when a stream is "in train," as it is termed, that the slope can be used to determine velocity; the surface of the water and the bed of the stream are then, to all intents and purposes, parallel. The attempt to obtain velocity from the small difference of level in backed-up water by ordinary slope formulæ is useless, and co-efficients derived therefrom are incorrect. In the determination of flood-levels, as a rule, there is little or no difficulty if the subject be properly approached, but very erroneous results can be deduced unless great care is taken.

The general character and inclination of catchment. — As regards these particulars, two areas, of the same extent, may vary widely as to the amount of rainfall discharged in a given time. The shape of a catchment is an important item; thus, a catchment running back from the outlet, say, 4 miles, and averaging a quarter-mile wide, will discharge rainfall at a much more regular rate than a catchment of the same area and nature of soil, but greatly differing in shape, which, for instance, might consist of a central creek into which several side creeks discharged at different points, although the amount of run-off in each case from a similar rainfall might be identical when the flow ceased. The long, narrow catchment might even never experience rain of sufficiently long duration to cause a maximum run-off at the outlet, whilst the differently-shaped catchment of equal area, supplied with what might be termed "feeder" creeks, would very likely discharge a maximum amount under a rainfall of similarly short duration. Thus the shape of a catchment and its characteristics are often of equal importance to its extent.

The shape of a catchment can be taken into account in the application of some formulæ, such as Bürkli-Ziegler, McMath, Adams, and Hawksley, indirectly, it is true, as no direct means has been provided, whilst the formulæ of Burge, Jackson, Steane, and Craig deal essentially with the shape. These latter, however, do not deal with the slope of a catchment, which also is of great importance; if this be uniform the discharge will begin from

Digitized by Google

zero, increasing to a maximum, providing the rainfall is constant and of sufficient duration to permit the water from the farthest point to reach the outlet, whilst it continues. As long as the rain continues, and the absorption is supposed constant, the volume at the outlet will be constant, and a maximum. When, however, in this case the rain does not continue sufficiently long for the water from the farthest point to reach the outlet, whilst it still rains, the maximum quantity will not be experienced.

When the slope of a catchment is not uniform, suppose a case where a railway runs practically parallel to a hilly range: the upper portion of such a catchment would be steeper than the lower portion, and the water would run off quicker from such steeper portions, thereby increasing the volume on the flatter portion, so that in such a case the maximum quantity might arrive at the outlet, though the rain did not continue to fall whilst the water from the farthest part of the catchment was travelling thereto.

The consideration of this question, from a theoretic point of view, as dealt with in the *Encyclopedia Brittannica*, would lead one to believe that the maximum flood at the outlet of a catchment will be continued when the rain continues long enough for the waters from the farthest point to reach the outlet while it still rains. This maximum volume will be the product of the number of acres in the catchment, by the rainfall in inches per hour, by the coefficient of run off. This is no doubt true as an abstract fact, and can be demonstrated mathematically on a suitably shaped catchment, but if the fetch of a catchment be so great, that no rainfall of such duration can be experienced, the slopes thereon are of the utmost importance, as may be seen on consideration of two catchments, one, "A," of uniform slope throughout its length, and another, "B," of gradually increasing slope from its outlet to its farthest point. If the fetch and nature of soil in both cases be equal and similar, "A" may never experience the maximum volume, whilst "B" would probably do so, both being subjected to a rainfall of equal intensity, but the duration of which would not be sufficiently long to permit

Digitized by Google

the water reaching the outlet from the farthest point of the catchment, whilst it still rained.

In view of the above considerations, it is evident that not one of the formulæ proposed is entirely general'; are they then to be discarded, and, if so, what course should an engineer pursue when designing a waterway through a bank? Before answering this, the following extracts from standard works and leading engineers as to practice in other parts of the world, may be noticed.

In Patton's *Civil Engineering*, under the head of "Water Reaching Streams and Sewers," it is stated:—

"The run off depends on such conditions, that the variations of formulæ as well as the difficulties of applying them to small city areas and large country areas alike, make the application unsatisfactory; formulæ, now applying approximately well for city areas, do not apply to country areas, where the storm discharges are carried off by creeks and rivers; the best formulæ now used seemed to be based on variable areas, variable slopes and variable rainfalls, the powers, roots, and constants, used in each, giving it its special merit." "Even with the best 4 formulæ for run off, 3 of them give curves for areas under 5 acres, shewing more run off than rainfall, and yet Bürkli Ziegler and McMath are more generally used, because of better agreement with observed run off from areas, say above 50 or 60 acres; none of these formulæ, and still worse, none of the various flood discharge formulæ, are satisfactory in very large country areas."

Professor Johnson, of Washington University, from whom the writer sought information, states, as regards design of waterways:—

"There is no fixed practice, and any engineer would find it hard to give any fixed rules for his own practice. Some roads always run out the watershed line, and find the drainage area of the stream or draw crossed, and then assume a maximum rate of rainfall, and use some formula for getting the maximum rate of run off from the area; character of surface and rainfall rate assumed, but in the end it is little better than a guess. We have a tradition here amongst our Railway Engineers, that it is only a question of time before any culvert will 'go out' by a flood, so you see we have no 'safe rule' to go by. Make them as big and as permanent as you can afford to do is the more common American practice, and if they go out 'charge it up to Providence.'

Mr. G. H. Pegram of the Union Pacific System, states:—

"The general practice has been for the locating engineer to size up the situation at a glance, as he goes over the road, and put down a '2 foot box'

Digitized by Google

or '8 panel trestle,' as may appear to his judgment right, and subsequent experience generally proves that he was wrong."

Mr. Foster Crowell states :—

"There are all sorts of conditions requiring all sorts of provisions, in the matter of waterway design; in unsettled districts the flood marks are as a rule more easily discernible than in the settled districts, and where the rainfall is known approximately, and the watershed can be conservatively estimated, even the absence of flood marks, itself a reassuring circumstance, need not preclude a correct diagnosis. A tentative treatment is, however, often resorted to in the adoption of a surplusage of opening, to be afterwards curtailed in the light of experience. In this country (America) reliable records are often lacking, even in settled communities, and where the consequences of erroneous conclusions would be most serious, thorough investigation of the possible discharge becomes a necessity. In the matter of culverts, the usual practice is extremely conservative, especially as under high embankments actual economy may be secured by an increase of diameter of the opening. The question of waterways should not be left until the time of actual construction, but be taken up with the preliminary surveys and in detail. It is, however, not good practice to steer very close to the theoretical requirements. Ample margin should always be allowed where practicable."

From other letters received by the writer from America and Canada, the practice seems to be, when a doubt exists as to the reliability of the result of a formula, a trestle is put in, about the sufficiency of which there can be no doubt, and this structure is observed in flood times, during a course of years, and when needing replacement is substituted by a permanent culvert, the size of which is determined by the observations made during the life of the trestle.

The formula most used in America seems to be that of E. T. D. Myers, President, Richmond, Fredricksburg and Potomac Railway. Mr. Myers states "that the co-efficient should be derived from careful and judicious gaugings, at characteristic points within the region under treatment, and applied with a liberal hand."

A valuable paper on "How to determine size and capacity of openings for waterways" has been compiled and published by the committee of the Railway Superintendents of Bridges and Buildings, in America, in which it is stated, *inter alia*, after

Digitized by Google

enumerating various formulæ "all these features, therefore, emphasize the difficulties of the task and the necessity of employing specially trained engineers, or expert hydraulicians, for all important work of this kind, as the true value of the application of theory to this problem is directly proportional to the correctness of the assumptions borrowed from practice; in the hands of a practical and experienced adept the data bearing on the case, consisting of part theory, part assumptions and observed facts, will be moulded into fairly good shape, and some tangible and valuable results obtained." The formula known as Bürkli-Ziegler's, when intelligently used, is (judged by the experience of the writer) as reliable as a formula of such a nature can be, and is preferable for general use to any other of the indicated formulæ.

During a recent investigation of the applicability of these several formulæ to local conditions, it was found that the only formula devised for general Australian use, and proved to be reliable in comparison with existing waterways, was that of Professor Kernot, of Melbourne University. Under certain conditions it is identical with that of Bürkli-Ziegler, the proof of which is as follows:

Bürkli-Ziegler's formula is—

$Q' = C R \sqrt[4]{\frac{S}{A}}$ where Q' = cubic feet per sec. per acre, reaching the outlet.

C is the co-efficient of run off.

R is the rate of rainfall in inches per hour.

S is the average slope of the catchment, in feet per thousand, and A is the area of the catchment in acres.

Now let Q = total run off, in cubic feet per second, from the catchment, then $Q = Q' A = C R \sqrt[4]{S A^3}$

Let S = 20 feet per thousand

Then $Q = 2{\cdot}1147\, C R A^{\frac{3}{4}}$

Now let the velocity of flow, through the proposed opening, be $4\frac{1}{2}$ miles per hour = 6·6 feet per second.

Digitized by Google

If O = area of opening in square feet, it

$$= \frac{Q}{\text{Velocity}} = \frac{2{\cdot}1147}{6{\cdot}6} \text{ C R A}^{\frac{1}{2}}$$

$$= 0{\cdot}32 \text{ C R A}^{\frac{1}{2}}$$

$$= 0{\cdot}32 \text{ C R } (640 \text{ M})^{\frac{1}{2}}$$

$$= 40 \text{ M}^{\frac{1}{2}}$$

= Professor Kernot's formula when C = ·5 and R = 2″

If C = 0·625 & R = 2″

$$O = 50 \text{ M}^{\frac{1}{2}}$$

And if C = 1 & R = 2″

$$O = 80 \text{ M}^{\frac{1}{2}}$$

The question now arises, after having by some means determined the amount of water to be provided for, what shall the nature of the provision be? This is a point about which engineers differ, though the scope for difference is much more limited than in choosing a formula for run off.

Let a typical case be taken. Say, for instance, where a catchment discharges 60 cubic feet of water per second, this quantity of water has to be passed under a railway or road bank, with safety to the bank and the structure itself.

A low velocity of discharge, except in special cases, is preferable for several reasons. For example, when a culvert is to be constructed, the facility for getting sufficient grade to attain a high velocity is very limited, for the outlet should be designed to provide a rapid get away. Surcharged culverts are not here considered. Another and more important reason is as follows: Suppose engineer M in adopting a velocity of six feet per second through his structure, requires ten square feet of section, and an engineer N adopting 18 feet per second, and, therefore $3\frac{1}{3}$ square feet of opening; then the latter will require less material, and design, therefore, a cheaper structure so far as first cost is concerned. Other effects, however, result, which may more than counterbalance the supposed advantage; as, for instance, if the velocity as designed, for some reason cannot be realized, the

Digitized by Google

culvert will not discharge the required amount, the consequence of which may be that the water will rise on the bank and cause a washout, endangering life and property.

In the case of M, however, if the assumed velocity be too low and it rises above 6 feet per second his 10 square feet of section only proves more than sufficient for the requirements, moreover the smaller culvert is more liable to become obstructed and rendered useless than the larger one.

Engineer N may, however, say if for any reason the velocity falls below 18 feet per second, the result will be that the water will rise over the mouth of the culvert, until the head so acquired furnishes the required velocity. But by what means can the increase in velocity be calculated? Such an outlet cannot be considered as an orifice, an adjutage, or a pipe under pressure. No experiments, within the writer's knowledge, have ever been made to determine velocity of efflux in such a case, the reason being, no doubt, that such investigation not being conformable would be unnecessary to good practice. The permitting of the flood waters to rise to formation level has been advocated by some, but what guarantee is there that they will not rise higher and cause a washout?

The attaining of a velocity greater than $4\frac{1}{2}$ miles per hour, through a culvert of this class, by artificial means, such as by surcharge at the outlet is undesirable. If a greater velocity can be attained by a natural inclination of the bed of the culvert, by all means let it be availed of, taking care, however, of two things—first, that the outlet is left naturally clear, so that the effluent water can get away from the culvert at least as quickly as it passes through it; and secondly, that the cross-section of the opening be not made so small as to render it liable to be choked up, as the latter would inevitably lead to surcharge, and possible wash away of the bank.

Now, as regards this velocity of 18 feet per second, supposing such could be attained by providing sufficient fall in the culvert with a free get-away at the lower end, as a general rule, in such structures, is it needed? The negative answer may be given,

Digitized by Google

not because injury would be likely to accrue to the structure, through the occasional occurrence of such a high velocity, but from the fact that the velocity of water approaching a culvert never reaches such a rate, and whilst decrying any attempt to reduce the natural velocity of approach, there does not appear to be any utility in increasing it for such a short length, as ordinary culverts reach.

Now, what is the natural velocity of approach of a stream. Is it not determined by one of two things, or, perhaps, by both—viz., the inclination of the bed, and the material through which it passes?

On page 164 of "The Australian Municipal Pocket Book of Engineering," compiled by J. H. Cardew, Assoc. M. Inst. C.E., will be found the following information as regards limits of velocity:—"To prevent injury to the bed and banks, the velocity of water, in feet per minute, in a channel should be proportioned to the tenacity of the soil." The minimum velocity is given for soft alluvial deposits as 25 feet per minute, rising to from 300 to 400 feet per minute for shingly and rocky beds. On the next page the velocities in feet per second are given at which various substances are carried off, that at which hard rock will be affected being 10 feet per second.

400 feet per minute, it is hardly necessary to remark, means $6\frac{2}{3}$ feet per second. Now, if this is correct, as undoubtedly the author of such a book would be, the maximum velocity in nature is 10 feet per second, and hence, except it is desired to shift creation, there can be no necessity for increasing this velocity of nature, especially when by doing so the only tangible result is to make the are theculvert so small as to render it liable to be obstructed.

Jackson, in his "Hydraulic Manual," states that the velocity of slow rivers is 0·33 feet per second, of ordinary rivers is $2\frac{1}{4}$ feet per second, and of rapid rivers is $10\frac{1}{4}$ feet per second, and also that the safe bottom velocities for the softer rocks, brick and earthenware, is $4\frac{1}{2}$ feet per second, and for hard rock from 6 to 10 feet per second.

Digitized by Google

Though much more might be said concerning this part of the paper, the second part will now be entered upon.

The question of providing for rainfall in connection with City or Municipal Engineering, is much more simple than the branch dealt with. The areas, as a rule, are of limited extent, the value of the coefficient of run off is much better defined, and no uncertainty should exist as to the rainfall.

The question of area presents no difficulty, and can be cheaply and easily arrived at by means of maps. The method of treatment, however, differs somewhat from the case of a railway, for whilst in that instance the configuration of a catchment as regards the existence of "feeder" creeks, running into the main one, is only considered, as regards the volume of run-off at some point on the main creek, in this instance the extent of the catchments of these several "feeder" creeks is of importance.

Take, for example, the case of a creek running through land in the neighbourhood of a city; whilst in this condition, rain water finds its way into the creek, at probably innumerable points along its course. As population increases, the area within the catchment of this creek becomes subdivided and built on. The original condition, regulating the flow of rainfall into the creek is altered—streets are constructed, the water channels of which discharge the rainfall into the creek in a concentrated form, in fact, the original catchment, which formerly could be treated as a whole, must now be considered as consisting of a number of catchments, discharging at definite points into the creek. The extent of these sub-catchments must be ascertained, and if a storm-water channel be constructed to supersede the original creek, its size must be proportioned to the several volumes from these sub-catchments discharging into it at definite points along its course.

Opinions differ as to the value to be given to the coefficient of run-off. As regards the City of Sydney and the western suburbs, the writer is of opinion its value should be a maximum, or in other words unity. There can be no question in regard to this in reference to a city—parks and open spaces being specially

Digitized by Google

dealt with; and as regards the western suburbs, considering the general nature of the soil and the fact that it is maximum rainfall which has to be provided for, as a general rule the coefficient should be a maximum; the mode of occurrence of maximum rainfall must be considered, as already pointed out, viz., during the continuance of what may be classed as moderate rain, which latter, however, tends to saturate the ground, so that the maximum rain should be considered as falling on impermeable surface. Even in the eastern suburbs, where the soil is sandy, and whilst in its natural condition calculated to absorb more than the soil of the other suburbs, still the coefficient should be high. The writer's practice, in such a case, has been to take unity as the coefficient, making an allowance in the extent of the catchment according to the nature of the dwellings erected, as, for instance, a catchment thickly built on, with terraces and asphalted yards, would be treated as impermeable, whilst an area of equal extent, on which detached residences with gardens, etc., predominated, would have a lower coefficient.

As regards the rate of rainfall, greater diversity of opinion exists. A rainfall at the rate of six inches per hour should be provided for, and has been used in the writer's practice for Sydney and suburbs. On many occasions, in the courts of this colony, it has been maintained that it is sufficient to provide for a rainfall at the rate of two inches per hour, with only 50 per cent. of that flowing off areas under 20 acres in extent.

What local authorities have to guard against is, that damage to property does not accrue from insufficient provision for flood water, caused by rain other than that of a phenomenal nature, and this less allowance, viz., for 2 inches, has been found inadequate.

Now, it is known that rain does fall from time to time in the neighbourhood of Sydney at the rate of 6 inches per hour, and should therefore be provided for, since it cannot be classed as phenomenal.

Chief Justice Darley, as reported in "Browning's Municipal Digest," has spoken as follows on this point:—"'Phenomenal'

Digitized by Google

rainfall meant a rainfall of an extraordinary nature, out of the common, and such as was not justified by past experience."

The practice of the Works Department is to consider a rainfall of 2 inches per hour, with only a percentage, rising sometimes as high as 50, flowing off. Of course, where large sums are proposed to be expended in storm-water channels, it may be debatable whether, from a pecuniary point of view, it is not advisable to provide for less than the maximum rainfall, so as to reduce the cost.

When the maximum quantity to be provided for has been decided, the engineer can easily provide facilities for its getting away in a safe manner, that is, so as not to injure property; and the question resolves itself into the calculation of the necessary size of pipe-drain, culvert, or open channel to carry off a given volume of water in a given time on a fixed or determined grade. Many formulæ have been devised for this purpose, but none is so generally applicable as that of Ganguillet and Kutter.

The question of rainfall, when considered from the point of view of water conservation, has to be dealt with in an entirely different manner.

With the exception of the bye-pass from a storage reservoir, it is not the question of maximum rainfall in a limited period that has to be considered, but the available volume from the minimum, mean, and annual rainfall.

The question of the length of time the water from a catchment will take to flow into a reservoir or channel need not generally be considered, so that slope or length of fetch has but little weight. It is the amount which may be expected to run off a catchment, and be available for conservation for future distribution, such as town supply or irrigation, which has to be considered. The question of evaporation does not under either of the other heads enter into practical consideration, but is here of vital importance. Percolation must also be taken account of. Both phenomena have been classed by recent writers under the head of absorption. This varies with the soil and climate. In many cases, however, water which is apparently lost by percola-

Digitized by Google

tion can be recovered by means of boring, so bringing it to the surface again, if the physical features of the district lend themselves to such treatment. Whilst it is most important, under the former heads, to know the maximum rainfall, under this head the mean and minimum rainfall, the latter both in amount and duration, should be ascertained. The maximum period, during which the demand for water exceeds the natural yield, determines the amount of storage required.

To properly deal with this branch of the paper in a thorough manner would occupy too much time. These few remarks will, however, sufficiently indicate how far its treatment differs from the other branches of the subject.

Discussion.

(Brief Abstract).

Mr. C. O. Burge said that as his name had been mentioned as the author of one of the formulæ quoted, he wished to say a few words about it, more especially as it had been included in a standard work—Jackson's "Hydraulic Manual"—as one of the three best-known formulæ in connection with flood discharge. He had been enabled, when in charge of about 100 miles of open line railway maintenance in India, to measure the maximum flood discharge for many years of a great number of large openings; and from this, and the data of the several basins, he had put together the formula in question. This, after publication in an article in the "Professional Papers on Indian Engineering," had been quoted in the Manual, with a criticism with which he was disposed to agree, and from there had got into Molesworth's Pocket-Book. That was nearly 30 years ago, but his experience since led him to distrust all formulæ on this subject. In all of them the constant had too much to bear. For instance, in the formula in question the constant had to include maximum rainfall in a given time, concentration of rainfall, percolation, evaporation, dissimilarity of tributaries from main stream, the influence of ponds or waterholes, &c., all of which varied so

Digitized by Google

much. But even when he published the formula he had accompanied it by a paragraph, which was quoted, to the effect that the evidence of flood marks and the experience of the engineer were to be preferred to any formula.

Mr. B. C. SIMPSON thought that all known formulæ were useless in determining the area of waterways for engineering works, since they were all empirical and founded more or less accurately on certain particular local conditions. The enormous discrepancy in the results obtained by different formulæ, and the correspondence given by the author of the paper from American and other engineers, both indicate the unreliability of formulæ. The author's assumption of a velocity of six feet per second was not in accord with facts. Ganguillet and Kutter gave many examples of rivers with a velocity of 13 feet per second. Professor Kernot's formula, founded on the success or failure of certain waterway works, could have no practical value unless the opening necessary for the outlet of a certain area of watershed had been determined by the success or failure of a very large number of such works, and the actual area of opening in each instance had been qualified by the constant which would be applicable to that particular watershed, according to his formula. The curve on which he based his equation was fixed at many points by only one or two examples. Mr. Haycroft's attempt to prove the similarity of Bürkli-Ziegler's formula and Professor Kernot's could only be described as mathematical juggling. Considering the unreliable nature of all known formulæ, and that the engineer must after all use his judgment in the selection of his formula, and in the application of his co-efficient, it was better to take the quantity of water falling on the watershed during the period necessary for the discharge from its furthest limits, and modify the total resulting discharge per second by a co-efficient which would be found to vary from ·05 to ·5, except in the extreme cases of town drainage; such coefficient to be arrived at by considering the conditions of shape, slope, and porosity of watershed.

Mr. CHAMIER said that for different catchments, varying from one square mile up to five hundred, the factor R in his

Digitized by Google

formula would decrease from 2 to $\frac{1}{2}$. The author, in making the calculations shown in his table, had made R constant throughout. He wished it to be clearly understood, therefore, that he rejected the whole of these calculations as erroneous.

Prof. KERNOT regarded the paper as a very complete and valuable compendium of what had been so far settled or conjectured on a very complex subject. With regard to his own formula, it was at best rough, and to be used only under limitations, yet it very fairly corresponded to the most satisfactory practice coming under his notice. Melting snow was a factor which, under certain circumstances, might be of great importance; in the case of warm rain in spring falling on snow it might be allowed for by an increase of 50% in the constant of his formula. He thoroughly agreed with the author's advocacy of self-registering rain-gauges. Very little had been said with regard to *storage*, but this in many cases appeared to give considerable relief, and permitted waterways to be reduced in size. As to the velocity of discharge through culverts, he had often gauged it in actual cases, and found it rarely to exceed 8 feet per second. Such velocities as 18 feet per second he considered utterly inadmissable, except in the case where everything in the vicinity was solid rock or masonry. The efficiency of culverts might be raised by making their inlets and outlets approximate in form to a *vena contracta*. He agreed that the co-efficient of run-off should be unity when the catchment consists of roofs, pavements, and hard metalled roads.

Mr. J. DAVIS thought that the author was to be complimented for his industry in collecting so extensive a list of formulæ. The paper was, however, disappointing, because, while the author fully appreciated and weighed the difficulties of the case, he practically left it in much the same position in which he found it. In considering the provision to be made for the discharge of water under railways, streams should be divided into two classes—viz., (A) those flowing from catchments over 200 acres, and, therefore, of comparatively large volume; and (B) those flowing from areas less than 200 acres. Usually in the

Digitized by Google

former (A) the discharge would be found to be of sufficient volume to have created a fairly well defined channel, and where semi-tropical rains are experienced, as in New South Wales, the flooding would have left distinct marks behind. The safest course in all such cases would be to depend upon flood marks and other reliable data obtained locally. The information thus obtained should be checked by taking in conjunction the drainage

STORMWATER DRAINAGE.

DETAILS OF RAINFALL PROVIDED FOR.

Name of Channel.	Drainage Area in acres.	Rainfall allowed for in inches per hour.	Length of Channel Constructed.	Length of Fetch above Channel.
Wallsend and Plattsburg ..	3040	⅛ inch	53 chains ..	3 m. 10 chns.
Orange Stormwater Channel	4600	⅛ inch	25 chains ..	—
Newcastle Pasturage Reserve Stormwater Channel ..	7787	⅛ inch	2 m. 64 chns.	2 m. 40 chns.
Homebush Creek—				
Upper portion	620	1 inch Albyn St. branch ..	—	—
		1½ in. Railway St. branch ..	—	—
Iron Cove Creek—				
Upper portion ..	1700	1⅛ inch	—	—
Lower portion ..		1 inch	—	—
Long Cove Creek—				
Upper portion ..	1000	1⅛ inch	—	—
Lower portion ..		1 inch	—	—
Johnstone's Creek—				
Upper portion ..	1147	1⅛ inch	—	—
Lower portion ..		1 inch	—	—
Rushcutter's Bay—				
Upper portion ..	330	2 inches ..	—	—
Lower portion ..		1¼ inch	—	—
White's Creek—				
Upper portion ..	830	1¼ inch	—	—
Lower portion ..		1 inch	—	—

areas, the maximum rainfall, and the grade which the water course would be likely to give when in flood. To compute the discharge for the latter (B), when the slopes are great, and the surface rocky or impervious, the only absolutely reliable course was to assume that the maximum rainfall would flow off at once, and make provision in the culverts accordingly. Referring to the typical case quoted on Page xli., presumably the Author would make provision for 6″ of rainfall over the whole of the catch-

Digitized by Google

ment. To this he could not agree. Assuming that some of the catchments to be provided for were small, then it might, perhaps, be safe to base the calculation upon 6″ of rainfall. This large provision, however, in his judgment, and in that of the authors of the formulæ given, was quite unnecessary. With regard to the author's assumption of a co-efficient of run-off equal to unity when designing storm-water channels in towns, experience proved that this assumption was wide of the fact, in proof of which the cases illustrated in the foregoing table were produced. Such channels had been built in every part of the city, and had proved ample in capacity to carry off the most severe rains.

Mr. C. J. Ross thought the author was to be commended for introducing a subject upon which such a diversity of opinion exists, and one which deserves more, and receives so little professional attention. Especially was this the case in Municipal Engineering, as his experience went to show that the matter was usually treated by the old "rule of thumb" method of personal judgment. He would mention one or two points that had occurred to him in dealing with the question. First, with regard to flood marks He had found that one might very easily be misled by accepting even apparently well-authenticated flood marks. Again, with regard to the basis of rainfall necessary to adopt for local municipal requirements, he agreed with the author in placing it at the six-inch rate, since this was not phenomenal, and (more especially as regards the immediate northern suburbs) the topographical features were very rugged, and, consequently, the gradients were, as a rule, steep, while the catchment areas were small. Again, the natural provisions for drainage were supplanted by artificial ones, and concentration was, therefore, made at every hand.

Mr. Cardew thought that the table of discharges in the paper compiled from the formulæ of Bürkli-Ziegler, Dickens, Fanning, and others, was, to a large extent, useless, either as a table of comparison or reference, since the author did not quote the factors employed in each—such as the rainfall, slope, length

Digitized by Google

of catchment, and co-efficient of discharge. The kernel of the whole question of discharge from catchments had been, in his opinion, entirely overlooked—viz, *the duration of the rainfall*, and its effects, both as regards intensity of precipitation and area affected. The period of maximum flow at the outlet of any drainage area during the progress of a rain-storm occurred when the flood waters from the remotest confines of the catchment, as well as those from the nearer slopes, were reaching the outlet at the same moment. The duration should be proportional to the distance of the outlet from the confines of the catchment. The paper was unsatisfactory in this respect—that, while the author thoroughly reviewed the question, he came to no definite conclusion.

Prof. WARREN thought that the use of a formula, expressing the law of flow in so far as it depends on the area and the rainfall, was desirable in estimating the discharge from a catchment, as the judgment of the engineer had then only to be applied to the determination of the co-efficient in the formula. The result would then be as correct as could be expected from the nature of the problem, and more correct than would be obtained by attempting to exercise the judgment on all the factors of the problem combined, *i.e.*, by guessing the size of the waterway. The formulæ of Dickens, Kernot, and Bürkli-Ziegler were identical, in so far that they each made the area of the opening, or the discharge, proportional to the three-fourths power of the area; but in the Bürkli-Ziegler formula, the engineer was enabled to exercise his judgment more in detail, and thus obtain more accurate results. The intensity of rainfall on areas of various sizes, and the time necessary for it to flow from the more remote portions of the catchment had been dealt with by Mr. Chamier. He agreed with the general remarks on rainfall made by Mr. Chamier, but he disagreed altogether with his method of introducing it into a formula. If, for example, 6 inches of rain fell on a catchment in six hours, and it took 12 hours for the rain falling on the most remote portions of the catchment to reach the outlet, then he saw no objection in a problem of this

Digitized by Google

character to assuming that the 6 inches might have fallen in 12 hours instead of six, and that the rate of fall was one-half an inch per hour; but having decided the proportion of the total rainfall which reaches the outlet, this should then be multiplied by the half-inch rainfall, to obtain the actual maximum flow of water in cubic feet per second per acre. The difficulty in this method was the determination of the time the rainfall took to run to the outlet from the extreme portions of the catchment; but having decided this, no reduction factor was necessary, excepting the C in Mr. Chamier's formulæ, which must include evaporation, percolation, and all retentions of flow. It was obviously absurd to divide the total rainfall by the time of flow from the remote portions of the catchment, and use the value so obtained for R in a formula of the Bürkli-Ziegler type.

Mr. MERFIELD said he wished to add to the already long list of formulæ another, that might be of interest*:—

$$0 = 440\ RM/V.$$

The author of the formula says: "The full amount of the rainfall per hour should be used in the formula, for areas of one square mile and less." This he assumes to be one inch per hour, but for larger areas he gives a table for the rainfall. He thought that the formula of Mr. Chamier might well have been eliminated from the author's list. Although it might to the uninitiated appear to be new, it could be shown by a simple reduction to be essentially identical in form with that of Prof. Kernot.

THE AUTHOR, in reply, said he could not agree with Mr. Burge in a general condemnation of all formulæ, except when they were of the type referred to, where the constant had so much to represent; it was, indeed, for this very reason that formulæ of the Bürkli-Ziegler type, when used intelligently, became useful. Mr. Simpson was in error in calling the various formulæ referred to *empirical*; as a matter of fact, these formulæ were *rational*, as they could be derived by the application of known laws, and there was a total absence of experiment, which

* 1. Jour. N.Z. Inst. Surveyors, vol. III., pt. 8. The notation is altered to agree with that used by Mr. Haycroft. V=vel. in miles per hour.

Digitized by Google

formed the essence of an empirical formula. Mr. Simpson's quotation of Ganguillet and Kutter as giving many examples of *rivers* with a velocity of 13 feet per second, and stating the assumption on the part of the author of 6 feet per second as not being in accord with facts, were due to misapprehension on Mr. Simpson's part. As regards this particular subject, he was quite aware of the existence of rivers with a velocity of 13 or more feet per second, but in no part of his paper could he be accused of advocating the application of a formula in such a case. It was, as was pointed out, where a formula was applicable, and the velocity of the water was unknown, as in the case of a creek with intermittent flow, that he considered it better and safer practice to assume a low velocity, for the reasons given. As regards the charge of mathematical juggling preferred by Mr. Simpson against the author, the latter was quite content to leave the matter in the hands of those qualified to give an opinion on this point. He agreed with Mr. Davis, and, indeed, so stated in the paper, that reliable flood-marks were preferable to any formulæ. He could not agree as to the hard and fast division of catchment areas into two classes, as proposed by Mr. Davis; and as an old railway engineer could assure Mr. Davis that such a course would be impracticable, however suitable it might prove in the design of storm water channels. As regards the typical case put forward by him, and referred to by Mr. Davis, the latter was in error as to his meaning. The illustration was given to point out the absurdity of *grading* the rainfall: he had never intended that provision should be made for a 6-inch rainfall over all the catchments between the terminal points, but only such of these as, through the extent of their areas and other circumstances, would render them liable to such a rainfall. Mr. Davis's table of storm water channels, which he produced to prove his (Mr. Haycroft's) assumption of a co-efficient of run-off equal to unity, in the case of town drainage, as being wide of the fact, was not pertinent, as he would never think of proposing such a value for areas of the extent given in the table. An analysis

Digitized by Google

of this table, however, proved very interesting. Thus, taking Johnstone's Creek area, the rainfall provided for was 1⅓ inches per hour, and the Rushcutter Bay area, the rainfall was 2 inches per hour. He was aware that in the latter case the increase in rainfall was made on account of the relative smallness of this area compared with the former; but Mr. Davis, in his practice, seemed to take no notice of the *nature* of the catchment. In the former case the catchment would be rendered practically impermeable after a gentle, soaking rainfall; whilst in the case of Rushcutter Bay, the nature of the catchment was such that, after several days' rain, very little would find its way into the channel. Mr. Davis stated that these channels had been constructed in every part of the city (Sydney); but he had yet to learn that any of those given in the table were within the city boundaries. Mr. Ross's remarks were *apropos*, and valuable, as coming from an observer, who, like the speaker, had to deal with such questions in his daily practice. Mr. Cardew's opinion of the table of discharges in the paper was fallacious, as the very information which he said was not given was stated very fully on the diagram, accompanying the paper, which was compiled from the table referred to. Mr. Cardew's remarks on the subject of the *duration of rainfall* were entirely novel, and personal to himself. According to Mr. Cardew's statement, if the duration of a rainfall were not sufficiently long to fulfil his conditions, maximum flow would not occur at the outlet. Nothing could be more absurd. The *direction*, and not the *duration*, of the storm was the controlling factor. A storm travelling in the same direction as the water flows off a catchment towards the outlet, would cause a flood of much greater volume (and in particular cases the maximum volume for such a catchment) than the same rain storm travelling in an opposite direction, or one at right angles to the course of flow-off, though in each case there was the same amount of rainfall. Again, the *duration* of rainfall by Mr. Cardew's method was pure guess work, which should be eliminated from all rational formulæ. In conclusion, he desired to thank the various members for their

Digitized by Google

outspoken criticism, and having been charged by some with not having propounded a definite solution of the matter, he begged to decline such a herculean task; indeed, in the paper he stated that this subject did not lend itself to general treatment. Each particular case must be decided on its merits—not, however, that he wished it to be inferred from this that formulæ which were put forward for general use might prove useless on that account; but that such formulæ, if used intelligently, can and cannot, according to its nature, be applied to a particular case.

Digitized by Google

SOME NOTES ON A WHARF RECENTLY BUILT IN DEEP WATER AT DAWES' POINT, SYDNEY, NEW SOUTH WALES.

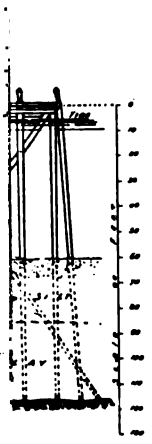
By NORMAN SELFE, M. Inst. C.E., M.I. Mech.E.

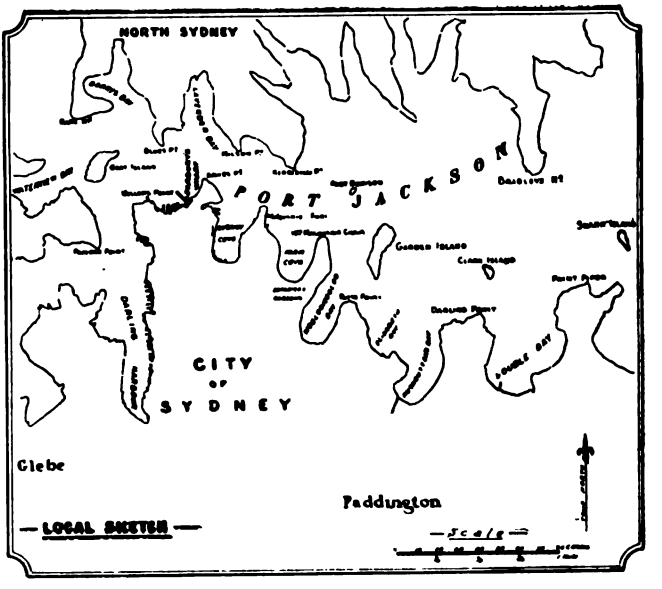
[*Read before the Engineering Section of the Royal Society of N. S. Wales, September 21, 1898.*]

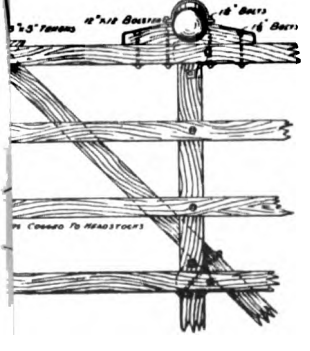
THE commercial enterprise necessary to the provision of private wharf accommodation appears to have been developed very early in the history of New South Wales. The first regular landing place was probably the "King's Wharf," still remembered as the "Queen's Wharf" by old inhabitants, situated between the Commissariat Stores and the Fire Station in George Street North. In a map of the town of Sydney, printed with the Sydney Directory for the years 1835 and 1836, every building then in existence, both public and private, is shown, and there are no less than six private wharfs at the North end of the town. They are Campbell's wharf, recently resumed by the Government; Walker's wharf, adjoining Dawes' Point, still known under the same name; Lamb's wharf, a little south of Walker's, and the site of the jetty to be presently referred to; Aspinall and Brown's, now the Central; and Bettington's, now Dibbs' wharf.

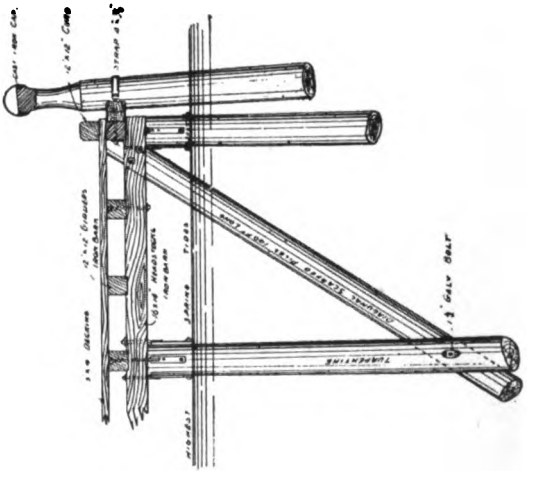
When the late Captain Lamb first established his business on the Southern half of what is now known as Parbury's wharf, there was a line of cliffs about 100 ft. back from the waterline; and although a small area (to straighten the frontage and give room for landing goods) has since been purchased from the Crown, the front of the houses in Lower Fort Street are still only 250 ft. from the old sea wall, and the street is 60 ft. above high water mark. With such a shallow depth to the property, and such a heavy rise to the street at the rear, a steep road was inevitable, and it was made worse by the sharp turn in it. Consequently the outlet from this wharf has had the reputation for many years of being one of the worst in Sydney.

Digitized by Google




NORTH SYDNEY
PORT JACKSON
CITY OF SYDNEY
Glebe
Paddington
— LOCAL SKETCH —
— Scale —





Digitized by Google

Digitized by Google

Digitized by Google

When, a few months since, at the expiration of an old lease, the wharf reverted to its owner, Mr. Chas. Parbury, it was understood that the lease was not renewed, owing to the supposed impossibility of building a jetty over such deep water and soft mud. Mr. Parbury thus found himself in possession of an isolated broadside wharf, with a water frontage of only 280 feet. of no use whatever in connection with modern ships; he, therefore, with a view to modernise and utilise his property to its fullest extent, consulted the author, who formulated the scheme of improvements which have just been completed. These include a forty-ton sextuple-power waggon hoist, with a platform thirty feet long, and the jetty which is the subject of this paper.

The dimensions of the jetty ultimately settled upon, and as built, are 350 ft. long and 60 ft. beam—as shown by the accompanying plan. When the position had been determined upon, two lines of soundings and borings were made, which showed that the rock was reached through about 50 ft. of mud or silt, and clay—approximately, about half of each. The upper 25 feet of silt is so soft as to be practically of no use as a support to the piles; but the clay is extremely tenacious, generally, when down fifteen or twenty feet into it. The rock bottom was found to be irregular, and falling to the north side; in some cases there was as much as nine feet difference in the width of the jetty.

The borings, when plotted as per plan exhibited, made two things very clear, viz., that the rock, through a great part of its length, was more than 120 ft. below the deck of the jetty, and that diagonal piles would have to be 140 ft. long. It was also seen that until the clay was reached, there was no support, either vertically or laterally for the piles. Sufficient vertical support could, perhaps, have been obtained by "collaring" the piles at the heavy clay line, but considerations of lateral stability determined that all the piles should go to the rock.

The specification stipulated that the piles at the toe might vary between 13 to 15 in. inside the bark, 14 in. being the

Digitized by Google

mean diameter, and so long as that size was maintained the contractor could use as many single-tree piles as he pleased.

The stipulations as to the heads were as follows (assuming that they might be obtained in one length):—

Piles up to	40 ft.	not less than	18 in.	at the	head
	60 ft.	„	„ 20 in.	„	„
	100 ft.	„	„ 22 in.	„	„
	120 ft.	„	„ 24 in.	„	„

There was found to be no difficulty in getting piles up to at least 100 ft. long to fulfil the conditions of diameter at the head, but such sticks of that length as were brought down for approval would not run more than about ten inches, instead of fourteen, at the point, which put them beyond consideration.

In formulating a method for building the long piles from two trees, it was considered by the author that anything in the nature of an ordinary diagonal scarf would be certain to fail. The stiffness of the bottom clay made it evident that there would be a lot of heavy driving, which would tend to burst ordinary scarfs, even if strongly hooped. It was, therefore, determined to make square butts, and to fish the two lengths together, instead of scarfing them. This was done as shown to larger scale on the plan.

The specification for the long built piles, stipulates that they shall be made from two turpentine trees with their butts together; these butts to be carefully fitted, when the two trees are "lined up" and drawn closely together, by running a saw through; which ensures contact all over the two ends. A 2½ in. iron dowell is permanently fitted and keeps them truly together while being "sided" for the fish pieces; these ends were specified to be not less than 24 in. in diameter, and they never were less, but generally exceeded that size—owing to the stipulation for the small ends. These butts were sided by shipwrights to 21 in. square as a minimum, or until there were four 12 in. faces, for each of the four fish pieces. The fish pieces were 14 ft. and 16 ft. long, 12 in. x 8 in. at the centre, and

Digitized by Google

12 in. x 6 in. at the ends, and they were put on the pile over "Ruberoid" pile covering. In the case of the bearing piles the "fish" was secured by four hoops of galvanised iron, each 3½ in. x ¾ in. section, and by twelve 1 in. galvanised bolts, nuts, and washers. The intermediate spaces between the fish pieces underneath the hoops were filled up with chocks driven hard the reverse way of the taper of the fish pieces, and kept from shifting by ½ in. spikes.

In the case of the diagonal piles, which run up to 140 ft. in length, and which might be subjected to a tensional strain in the case of lateral pressure by a vessel against the jetty, there were no hoops used; but 24 1 in. bolts were inserted instead of twelve, as in the other piles. The stipulated minimum diameter of the top of the long piles (that is, the small end of tree), was 19 in.; and, in order to secure this size, the timber was often much above the specified diameter at the butt, as just referred to.

There is nothing unusual to note about the deck framing and planking, but as the piles were so large and heavy, 12 ft. centres were adopted, instead of the more usual distance of 10 ft. and the head stocks were 16 in. x 14 in. ironbark, instead of 14 in. x 14 in., which is the more common scantling.

These pieces of timber (every one in one piece 60 ft. long 16 in. x 14 in., and carefully hewn from selected ironbark trees), were magnificent samples of what our native forests can produce. The 12 in. x 12 in. ironbark joisting girders at 4 ft. centres were cogged down 2 in.; and the 12 in. x 12 in. diagonal deck bracing was fitted up from below. The planking is 4 in., and the kerb 12 in. x 12 in. all very much as usual in the port.

With regard to the use of diagonal piles to support a jetty, instead of walings and braces above the water line, it is generally known that they were first proposed in Sydney by the author 25 years ago, in connection with the improvements he designed for the Circular Quay; and although his proposals were not adopted in their entirety, Parliament subsequently voted a gratuity of £500 to him for his services in the matter, and this system of

Digitized by Google

staying a jetty by diagonal piles has since become common in Sydney harbour; it was the only one possible in this case. In securing the diagonal piles, there are not only bolts to the head-stocks and girders at their heads, but also two 1½ in. galvanised bolts, put in by divers, right through at their intersections with the vertical piles.

When the jetty was approaching completion, permission was obtained from the Government, and a few hundred tons of sand-stone ballast were dropped on to the soft mud around a few of the piles near the end, to act as a stiffener. The author is indebted to Mr. C. W. Darley, Engineer-in-Chief, for the suggestion to put this ballast on a mattrass, made of timber framing and ti-tree façines, in order to keep the ballast together, which plan was adopted. The line shown on the drawings (ascertained after it had had some weeks to settle) shows that it has not spread as might have been anticipated from the softness of the mud.

When the piles were 60 feet in the water, they were often more than 20 feet above the head of the pile driver, and had it not been that the soft mud allowed them to be dropped from 20 to 25 feet into it, that is from 80 to 85 feet below water line, a pile driver, with shears from 70 to 80 feet high, would have had to be built specially for the work.

Probably the most interesting matter to many members in connection with such a work, is the pile driving, and the author regrets that he has not collected sufficiently accurate data to supply material for a new formula. Personally, he has no great faith in the practical value of any pile driving formulæ, because, for actual work, the pile last driven generally affords information to guide the engineer as to the treatment of its neighbour, which no theory can supply. Some particulars, however, were taken of a few piles, which may be a guide for future work of this kind The provisions of the specification as to ram or monkey, were that short and rapid blows would be preferred by Sisson's Lacour's or Nasmyth's machine, and that the engineer was to be satisfied that all piles reached the rock, and have any pile drawn he disapproved of.

Digitized by Google

PILE A.—Length, 117 ft. 3 in.; diameter at head, 20½ in.; toe, 16 in.; girth at 63 ft. from bottom, 67 in.

This pile went down about 30 ft. into the soft mud by its own weight when let drop from the slings, and required 18 ft. 3 in. of ordinary driving until the last 5 feet was reached. It was then driven home with the number of blows, and the height of fall as follows :—

NUMBER OF BLOWS.	HEIGHT OF FALL.
Two	6 feet
Twenty-five	7 feet
Fifteen	8 feet
Ten	9 feet
Seven	10 feet
One	11 feet

The total fall was 478 ft., the number of blows 60, and the average distance driven was 1 in. per blow.

PILE B.—Length, 126 ft. 6 in.; head, 18½; toe, 13 in.; girth at 54 ft., 73 in.; ram, 32 cwt.

This pile is 58 ft. 2 in. in the mud altogether; say, 28 ft. 2 in in the soft, and 30 ft. of driving, as follows :—

First 5 ft.—Ten blows ...	3 ft.	21 blows, 74 ft. drop.
Eleven blows ...	4 ft.	
Second 5 ft.—Twenty blows ...	4 ft.	36 blows, 169 ft. drop.
Seven „ ..	5 ft.	
Nine „ ...	6 ft.	
Third 5 ft.—Two blows ...	4 ft.	52 blows, 202 ft. drop.
Seven „ ...	5 ft.	
Nine „ ...	6 ft.	
Five „ ...	7 ft.	
One „ ...	8 ft.	
Five „ ...	10 ft.	
One „ ...	12 ft.	

Digitized by Google

Fourth 5 ft.—Seven blows	...	8 ft.	36 blows, 365 ft. drop.
Eight „	...	9 ft.	
Nine „	...	10 ft.	
Three „	...	11 ft.	
Three „	...	12 ft.	
Six „	...	13 ft.	
Fifth 5 ft.—Twenty blows	...	9 ft.	54 blows, 494 ft. drop.
Fifteen „	...	10 ft.	
Fifteen „	...	8 ft.	
Four „	...	11 ft.	
Sixth 5 ft.—Seven blows	...	9 ft.	33 blows, 336 ft. drop.
Ten „	...	10 ft.	
One „	...	8 ft.	
Fifteen „	...	11 ft.	
Total	...	...	232 blows, 1,640 ft.

This evidences great inequality in the strata passed through, and shows that it is softer at the bottom than it is some distance up.

PILE D.—130 ft.; girth, 77 in. 56 ft. up; toe, 15 in.; head. 20 in. (Heavy pile). Ram, 32 cwt.

This pile was left over-night, after being driven for 15 ft. It took six blows from 10 ft. to 12 ft. before it would start to drive the last 15 ft. After extending the jetty out some distance the clay became stiffer, and, as the driving was harder, several piles showed that the high falls were severe on their heads. The author then insisted on a heavier ram (not less than 60 cwt.) being procured. This new monkey, when obtained by the contractor, actually weighed a little over 61 cwt., and from this time out no more trouble was experienced, and the driving was done in about half the time it previously occupied.

PILE F.—118 ft.; head, 20 in.; toe, 16 in.; girth at 50 ft. up, 68 in.; length above the "fish," 42 ft.; 61 cwt ram.

No difficulty in driving. This pile is typical of most which were driven after the heavier ram was obtained, half an inch per

Digitized by Google

blow being obtained in the last 10 ft. without requiring generally more than a 5 ft. fall, instead of 11 ft., 12 ft., and 13 ft., as was required for the same work with the lighter ram, and this with little or no tendency to split the piles.

The only other departure from ordinary practice, perhaps, is in connection with the fender piles, which are secured into an ironbark bolster in the ordinary way, by a heavy strap and two bolts. Instead, however, of having a shallow iron cap, hooped, as usual, these tops are made to a section which shows three-quarters of a sphere externally, and with a good taper conical interior; they are dropped over about eight inches of the piles' heads, which are wrought conical to receive them, and they are thus enabled to settle down, and always fit tightly as the pile-head shrinks.

Digitized by Google

NOTES ON HYDRAULIC BORING APPARATUS.

By G. H. HALLIGAN, CHIEF SURVEYOR PUBLIC WORKS DEPARTMENT N.S. WALES.

[*Read before the Engineering Section of the Royal Society of N. S. Wales, October 19, 1898.*]

IN nearly all branches of engineering, it is desirable, if not necessary, where large works have to be carried out, to know what material underlies the surface, and various means have been adopted to obtain the information economically and speedily. The old practice of sinking shafts and thus exposing to view the strata passed through, has, under certain circumstances, much to recommend it. Shallow holes, from 10 to 30 ft. deep, in stiff loamy soil or clay, can be sunk for from one shilling to two shillings per foot. When timbering is not necessary, and where only a few holes are required, or a small area is to be investigated, it is doubtful if any boring plant could be got to do the work more effectively or for the same money. But it is seldom the engineer is fortunate enough to strike such ideal spots. If the lower strata should be sandy, or if water be met with, sinking becomes expensive, if not impossible, and the boring plant is called into requisition. When the surface is swampy or wet, or where the strata underlying a creek or river are to be examined a boring apparatus of some sort is necessary, and it is the object of this paper to indicate the methods adopted and the results obtained by the gear of which the author has immediate charge. Nothing new is claimed in the general design of the various apparatus employed, but a brief description of the difficulties encountered, and the means employed to overcome them, a list and short account of the principal tools used in the work, and last, but not least, the cost of the outfit and the cost per foot of the work done, may be interesting.

The system of deep earth boring by means of a diamond drill becomes difficult and very expensive, if it does not entirely fail in soft and especially in gravelly strata. A thin bed of this

Digitized by Google

nature very seriously retards the progress of boring, and it is mainly this defect which prevents the diamond drill being used more extensively for many purposes for which it is otherwise so admirably suited on account of the solid core which it brings up. Another objection to the use of the diamond drill, in many instances, is the necessity for providing an absolutely rigid staging from which to work, and a solid foundation for the engine working the rotating tool. When work has to be done afloat this objection is, of course, insuperable, and numerous devices have been tried to enable holes to be sunk from a moving stage or punt. Much ingenuity and ability have been expended in perfecting the methods of boring to great depths, on shore, by the many processes now in vogue, and the number of improvements continually being made in the machinery and apparatus used, is perhaps, the strongest evidence of its imperfection even now. So far as the author is aware, nothing has been written on the not less important subject of boring in deep water, but though the means are not new, yet the results obtained are, in some respects, unique.

Advantage has been taken of the experience of others in selecting the tools most suitable for the work to be done, but it has been found that special circumstances called for special tools, experience being the best guide in matters of this sort.

The apparatus now in use by the Department was originally designed to ascertain the nature of the bottom of the Harbour down to about 40 feet below low water; but as circumstances arose necessitating an extension of this depth for bridge foundations the gear has been gradually improved and added to, and the present outfit is capable of boring through any material not harder than the Hawkesbury sandstone to a depth of at least 600 feet. In designing the gear at present in use it was necessary to keep in view the fact that no very extensive boring work is done in any one locality, so that the portability of the apparatus is of serious moment. The length of time occupied in putting together the material required to sink a few holes in distant parts of the country is also important, as affecting the

Digitized by Google

cost of the work, while the freight charges on cumbrous packages are not seldom prohibitive when prospecting or other work involving an uncertain return is being carried out. The diamond drill is necessarily expensive when comparatively shallow bores of from 400 to 600 feet are to be sunk, and the Calyx drill is scarcely less so. A suitable outfit to be worked by unskilled labour, under the guidance of one practical mechanic, would, undoubtedly, be in large demand in the Western country, where good work could be done by it; and it cannot be too strongly insisted upon that the main success of any boring machine depends



Fig. 1.

not so much on the mechanical perfection of the apparatus, or on the number of hands employed, as on the ingenuity, resourcefulness and energy of the directing mind. The value of a good foreman is not to be expressed in dollars; he may save more in one hour than he receives in 12 months.

Digitized by Google

Four men are employed on the ordinary boring apparatus shown in Fig. 1. This illustration shows the sheer legs on two punts coupled together as used in boring afloat, and the tools here described are those employed on this work, though, with very little modification, they could be, and, in fact, are being used for land boring. There are, however, certain essential differences, and these will be noticed as we proceed. The punts here shown are each 37 ft. long, 12½ ft. wide, and 3¼ feet deep, and are large enough to enable any boring to be sunk within the capacity of the apparatus. They are temporarily bolted together, having a space one foot wide between them. In this space the boring tubes may be lowered as required, generally in the centre of the opening so that any strain caused by lifting or forcing down the tubes may be equally distributed and save injury to the punts.

Four inch tubes are generally used, having an inside diameter of 3⅝ in. This size has been found to be sufficiently light to allow of convenient handling, and large enough to allow fairly coarse gravel to be picked up with the tools, without the necessity of too much pounding. With smaller sized tubes, the tools must be so small that sufficient strength cannot be given them to allow for wear and tear, while if larger tubes are used, the outfit becomes too heavy and unwieldy for convenient and economic working.

The author would here like to say a word in favor of butt-joints for all tubes where much forcing down or hammering has to be done. Experience has not shown that the union joint offers any more obstruction to the withdrawal of the tubes than the swelled joints, but it is infinitely better as regards its ability to withstand driving, and it is not so liable to become unscrewed. Where it is necessary to purchase swell-jointed pipes, it is found to be economical to have the female screw cut off and union joints made before starting any deep boring. On several occasions the tubes have telescoped at the swelled joints, when subjected to severe driving through obdurate material such as stiff clay, coarse gravel, or indurated sand.

Digitized by Google

It is better to buy good artesian well tubing than to use a cheap gas piping or boiler tubes. Not only is the artesian tubing straight, and of even diameter, but it is free from knobs and is fairly homogeneous in structure; but such cannot certainly be said even of the best gas pipe. The price of the best 4 in. Russian artesian well tubing in Sydney is 2s. 2d. per foot, gas pipe of the same size is 1s. 2d. per foot, and boiler tubing 1s. 1d. per foot.

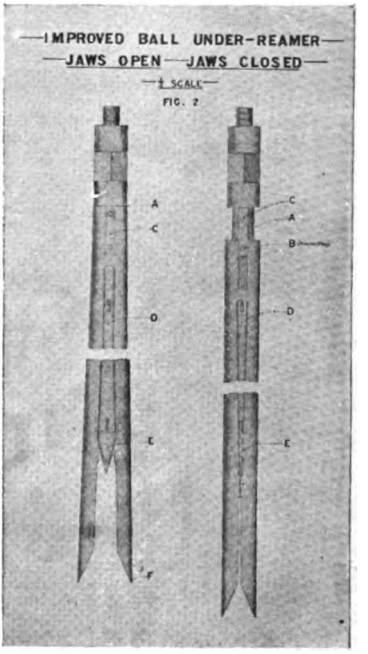


FIG. 2.

At the bottom of the tube is a hardened steel cutter to withstand the driving through hard material.

When the tube is lowered to the bottom, the flexible hose from the pump is connected to the top, as shown in Fig 1, and the pump started. The tubes are then lowered as fast as the mud

Digitized by Google

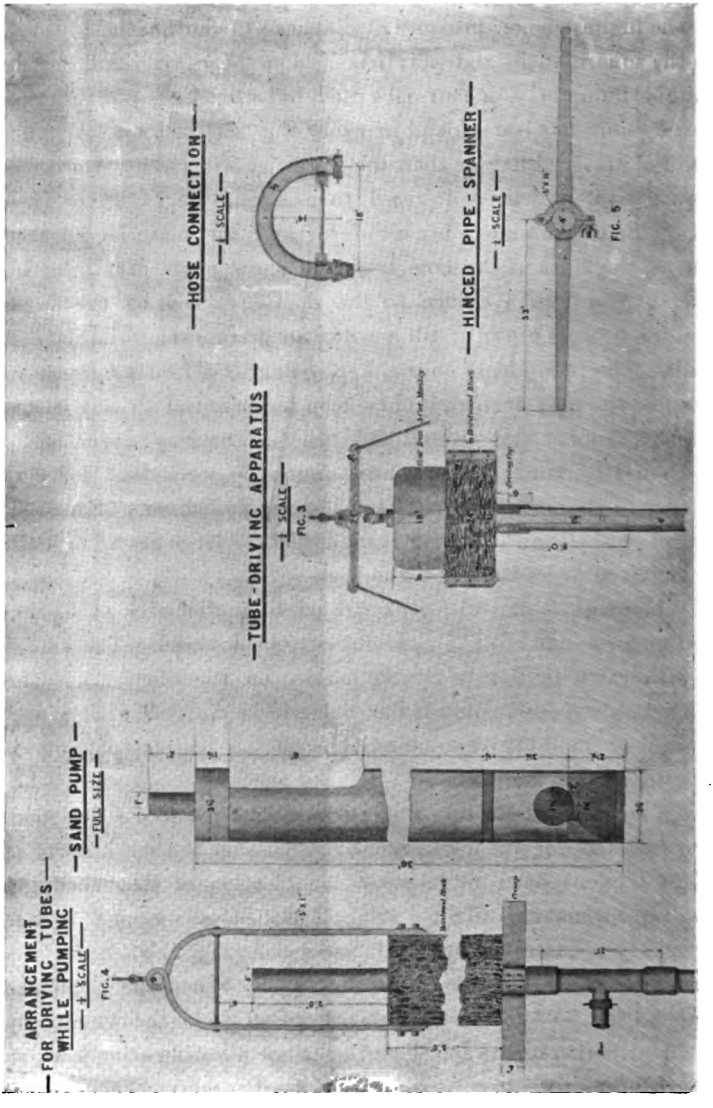
or other material is scoured away, the rate of progress depending, of course, on the material to be passed through.

The highest boiler pressure available to the author is 110 lbs. to the square inch, and this has seldom been required. Any suitable pump may, of course, be used, but a 6 x 4 x 6 Worthington steam pump has been found in every way satisfactory. When a band of material harder than the water jet will readily overcome, is met with, a drill is lowered to ascertain its nature. If it should be clay an auger is sent down and the material augered out till the sides of the hole begin to show signs of falling in. The tubes are then driven to the depth reached by the auger and the process repeated till a softer or harder material is met with. The pump is, of course, kept going to soften as much as possible the clay or mud, and to keep the material already passed through from settling round the tube. The clay auger has a pitch of 4 in., and this has been found to work best for clay similar to that overlying the Hawkesbury sandstone. For small gravel or shells a shell auger is used, and for large gravel or drift a double corkscrew auger is the best.

When rock is met with it is drilled to a diameter of $3\frac{1}{2}$ in., and under-reamed to allow the tubes to be lowered. The sludge is withdrawn by the sand-pump (shown on the diagram). The hinged-valved sand-pump is too liable to be clogged with grains of sand or small gravel to be reliable, so the ball-valve pump is now invariably used.

An entirely satisfactory under-reamer has yet to be designed The best tool for under-reaming by percussion is that known as Ball's Under-reamer, or rather a modification of it, embodying two improvements. In the original Ball Under-reamer it was necessary to insert a plug of soft wood at A (Fig. 2) when the jaws closed ready for lowering into the tube. When the appliance reached the bottom this plug was supposed to be thrown out by the contraction of the spiral spring, thus allowing the jaws to open to the full extent (as shown on the diagram). This seemed feasible enough, but the plug did not always answer to the call. It either fell sideways and thus allowed the jaws to open to only

Digitized by Google



FIGS. 3, 4 AND 5.

Digitized by Google

half their full extent, or it became jammed between the tool and the side of the tube, and prevented any movement one way or the other. To get over this difficulty the improved appliance was provided with a sliding shutter C, flush with the outside of the tool. When the jaws are closed a wooden plug is inserted in the conical hole B, thus keeping the jaws from opening until the tool strikes the bottom. The force of the blow shears the wooden plug, and the jaws at once expand. There is nothing to cause a jam in the pipe, and the appliance cannot fail to act. The second improvement was the lengthening of the distance from the expanding plug E to the cutters F, thus allowing for less spring in the steel jaws and less liability to injury at E.

The method of driving the tubes through clay or soft rock, where under-reaming is difficult and slow, is shown in Fig. 3, and calls for no description. When it is necessary to keep the pump going while hammering the tubes, the arrangement shown in Fig. 4 is adopted. On account of the difficulty of getting any cramps to hold on the smooth tube, no heavy driving can be done with this appliance without injury to the pipe.

The hinged spanner or cramp, shown in Fig. 5, was designed to save time on the work. Most of the fishing tools, augers, drills, etc, have already been described in detail in a report on "Drilling and Boring Artesian Wells, as practised in the United States of America," by C. W. Darley, M. Inst. C.E., under whom the author has the pleasure to serve, and to whom he is indebted for much valuable advice and assistance in connection with the work now being described.

The sections of some of the bores carried out with the apparatus here referred to (Figs. 6, 7, 8), show that it is capable of valuable work, and the attached statement giving the cost will show that it is done at a reasonable rate. The cost of the work done out of Sydney includes freight charges by steamer, rail or dray to and from the work, as well as the fares of the men, repairs to gear and incidental expenses, and the cost of raising the tubes.

Digitized by Google

Locality.	Strata Passed Through.	No. of Bores.	Total Depth Bored.	Cost per Foot.
			ft.	s. d.
* Manning River, Killawarra and Bungay	For the most part through shale with a little sand	13	345	5 0
* Camden Haven ...	Principally indurated sand	77	2035	1 8½
* Moruya	Sand, decomposed granite, etc.	7	152	3 8½
* Camden	Sand and gravel, with bands of stiff clay ...	4	207	3 8¾
*Dunmore, Patterson River	Drift and clay	5	309	2 7
* Hinton, Patterson River	Alluvial, sand and drift ...	4	118	3 1
* Murwillumbah, Tweed River . .	Sand, clay and drift, bands of soft rock	10	540	3 0
Blue's Pt., Sydney Harbour	Mud, sand, clay, and ballast	12	184	2 5
Pyrmont Bridge, do. ...	Mud, clay, and soft rock...	32	654	2 0¾
Dawes Pt. do. ...	Mud, sand, and soft rock	93	380	2 10¾
Sydney to North Shore Bridge ...	Mud, sand, clay, and soft rock	35	1818	2 0½

* Hydraulic pressure was not used on these works.

On the last mentioned work a careful record was kept of the progress of the work and from it the following information has been compiled :—

Boring through 1161 ft. sand and clay, and soft sandstone by hydraulic pressure 9d. per ft.

do. 320 ft. stiff clay and soft sandstone by boring tools only... 3s. 4d. per ft.

Drilling through 337 ft. soft and hard sandstone... 5s. 3d. per ft.

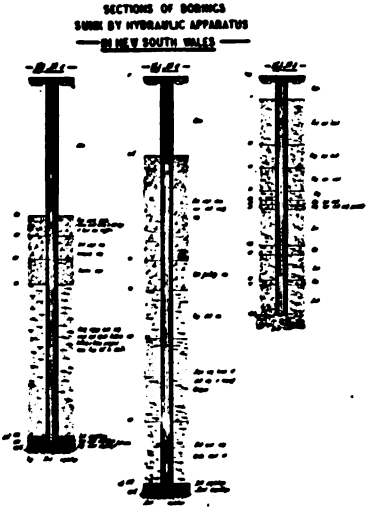
Total drilling and boring ... 1818 ft. 2s. 0½d. per ft.

Under favourable circumstances the tubes have been sunk through coarse sand or mud 30 feet in one hour, and through stiff mud or soft clay from 10 to 15 feet in the same time. The clay that cannot be pierced by the 4 in. boring tubes under hydraulic pressure of 110 lbs. to the square inch is very stiff indeed. At Funafuti a depth of 108 ft. of coarse *Halimeda* sand and coral gravel was pierced in 22 hours, and from this time 3 hours may be deducted for repairs to faulty hose, etc., giving 19 hours of actual work.

When the depth of water exceeds 80 ft., driving the tubes has to be conducted with great care even in perfectly smooth

Digitized by Google

water. If any movement of the boring punt takes place, owing to the swell, variable current, or other causes, and a true blow cannot be struck, its force is lost in the spring of the tube and serious injury to the pipe is caused. This was particularly noticeable when sinking the bores lately at the atoll of Funafuti in 101 feet of water. The work was carried out by the author from the bow of H.M.S. Porpoise, kindly lent by the Admiralty for the purpose, but, although the water in the lagoon was as smooth as it generally is in Port Jackson, the oscillation of the



FIGS. 6, 7 AND 8.

ship prevented a true blow being delivered, when it became necessary to drive the tubes, and the work could not be continued. From a double punt, such as already described, where, of course, no oscillation takes place, some heavy driving through stiff clay and soft rock has been done in 80 feet of water. It is, however, doubtful if the 4 in. tubes would stand much hammering in a greater depth of water, however carefully done.

The author wishes here to acknowledge his indebtedness to Mr. H. Fleming, Resident Engineer Public Works Department, to whose skill and constant care a large measure of the success of the boring apparatus here described is due.

Digitized by Google

NEW SOUTH WALES LIGHTHOUSES.

By H. R. CARLETON, M.A.I., M. Inst. C. E.

[*Presented to and discussed at the Engineering Section of the Royal Society of N. S. Wales, December 21, 1898.*]

Coast Surveys.

If one of the early navigators could revisit the shores of Australia, he might well wonder how he could have done such good work without the lighthouses, lifeboats, pilot steamers, charts and sailing directions which we now look upon as necessities of our maritime life. Those old mariners from Eredia in 1601, De Quiros and Torres in 1606, Edel in 1623, Peter Nuzts in 1627, Dampier and Cook in 1770, had rough work exploring and charting the broken coast line of Australia, and R. de Vaugondy's map of New Holland in 1752 shows how wonderfully these early chartographers could utilise the primitive appliances at their command. It was not until 1799, or twenty-nine years after Cook landed at Botany Bay, that a systematic attempt to obtain a chart of the coast of Australia was made, but in that year Commander M. Flinders, in the sloop *Investigator*, commenced a survey embracing the whole of the east coast, from Cape Howe to Cape York. His chart of Terra Australis was published in 1814, and copies are now very rare. Soundings were taken about every three miles on the ship's course, and the principal islands, reefs, shoal patches, land marks, etc., sketched in.

These early reconnaisance surveys have proved to be remarkably accurate when we consider the nature of the work and the class of instruments then available. Almost the whole of this work is done from the vessel's deck while working along the coast under sail, checking being done by astronomical observations as often as circumstances will permit. In these days of patent logs, sounding machines, and steam launches, such work is comparatively simple and expeditious, but before steam vessels were known, or patent logs invented, the work required more seamanship, and more time to attain anything like a fair amount of correctness.

Digitized by Google

An accurate survey of our coast extending from the shore to beyond the 100 fathom contour, shewing all reefs, islands, nature of the bottom, and variations in depth, was completed by joint arrangement between the Admiralty and the Colonial Government in 1889, and leaves nothing more to be desired in this respect. It is not unusual when a vessel has been wrecked to attribute the cause to striking on an uncharted rock, but when these statements have been investigated before the properly constituted tribunal, in no single instance have they been substantiated.

Wrecks on Coast of New South Wales.

A complete record of the wrecks on the coast of New South Wales has been kept by the Marine Board since the establishment of that body in 1871. Only the more notable wrecks seem to have been recorded prior to the creation of the Board.

Between 1873 and 1896 419 wrecks occurred on the coast, consisting of 96 steamers and 323 sailing vessels. The total tonnage lost amounted to 68,817 tons, carrying in crews and passengers 4,344 souls, and the number of lives lost was 595, or an average of one person in every seven wrecked. The estimated value of the vessels lost during this period is £1,180,736, and 134 vessels of those lost were insured to the amount of £335,345. The greatest number of lives lost in any one vessel was 71 in the *Ly-ee-moon*.

Ninety-nine wrecks occurred through foundering at various points along our coast line, 34 wrecks have taken place at Port Stephens, which place is chiefly used as a harbour of refuge, 28 wrecks occurred at Sydney, 27 at Newcastle, 24 at the Richmond River, and the others as shewn in the table (Appendix I.)

Earliest Lighthouses on Coast.

Macquarie Lighthouse was the first building of its description erected in New South Wales—the first lighthouse in the Southern hemisphere. Its foundation stone was laid on the 11th July, 1816, by Governor Macquarie, as the following extract from the *Government Gazette* of 13th July, 1816, sets forth:—"On Tuesday last, notwithstanding the severity of the weather, His Excellency

Digitized by Google

the Governor and staff, accompanied by His Honor the Lieutenant Governor, the Judge Advocate, and Captain Gill, the Principal Engineer, proceeded to the South Head where (everything being in readiness for the occasion) His Excellency was pleased to lay the foundation stone of a most useful building intended for the several purposes of a signal and lighthouse, and a guard house and barracks for a small military detachment. The centre of this building, we understand, is to be raised 65 feet above the level of the eminence on which it is placed, and will form a square pyramidal tower, on the top of which a light is to be placed for the direction of vessels approaching the coast, which from its elevation will be seen at an immense distance at sea, and be an object handsome to behold from the town of Sydney. The wings of the building are to form the guard house and barracks. Huge blocks of excellent stone are prepared for the edifice, and afford the strongest assurance that it will prove a permanent security for all vessels that may approach the coast. To this building which opens the prospect of a monument for future ages to contemplate with pride, His Excellency gave the name of Macquarie Tower, and when considered with a view to the commercial interests of this colony, it cannot fail of proving a most valuable and important acquisition." A correction of the description appeared in the *Gazette* of 20th July, 1816, and ran as follows:—"The centre of this handsome building is to be raised 65 feet above the eminence on which it is placed, and will form a square base or pedestal with a circular tower crowned with a frieze, on which will be carved the four winds in *alto relievo* distributing their good and evil qualities from their drapery as they appear to fly round the tower, above which will be a cornice and lantern with revolving light, the whole forming an appropriate capital to the tower. On the inside is intended to be a geometrical stone staircase leading up to the lantern, and two *basso relievos* will be on the pedestal. The wings of the building are to form the guard house and barrack."

The building was designed and executed under the superintendence of Captain John Gill, Acting Engineer; Francis Howard

Digitized by Google

Greenway was the Architect. The tower was completed in 1817, but it was found necessary to repair it in 1822, as the construction was considered faulty. The light is said to have been of the third order catoptric.

The second light erected appears to be the Beacon Light at Newcastle, the earliest record of which is 1828. The third is the floating lightship at the entrance to Port Jackson in 1836, and the fourth Gillibrands Point or Williamstown, Port Phillip, in 1842.

The Superintendent of Port Phillip selected Cape Otway as a site for a lighthouse on 21st April, 1846, and Mr. C. J. Tyers was sent to select sites for lighthouses at Cape Howe or Gabo Island in 1846.

ADMINISTRATION.

The first lighthouses appear to have been directly under the control of the Colonial Secretary's Department.

In 1825 an Act was passed authorising the payment of tonnage rates into the hands of the Naval Officer for the use and maintenance of the Port Jackson (Macquarie) Lighthouse. In 1832 a similar Act was passed but directing that the payments should be made to the Collector of Customs for the maintenance of the Lighthouse.

In 1843 Her Majesty was pleased to appoint Herion Marshall Moriarty, Esquire. Lieutenant in the Royal Navy, to be Portmaster in the colony of New South Wales, and this gentleman's predecessor appears to be the Officer referred to in the 1825 Act.

The date of the appointment of the first Pilot Board is uncertain, but in 1862 there existed a Department of Harbours, Lighthouses and Pilots. This Pilot Board consisted of W. A. Duncan, Chairman; Captain T. Watson, Captain R. Towns, Captain Rountree, Captain Vine Hall and W. F. Norrie. This Board resigned their appointments 26th November, 1862, and the new Board appointed comprised—Pilot Board:—F. Hixson, R.N., John Crook, C. Harrold, for issue of certificates only. Superintendent of Pilots, Lighthouses and Harbours:—F. Hixson, R.N.

Digitized by Google

Steam Navigation Board:—E. O. Moriarty, Chairman; B. Darley, C. Smith, J. Watson and H. T. Fox.

The lighthouses are now under the jurisdiction of the Marine Board appointed under the Navigation Acts of 1871-96.

Lighthouse Optics.

Before describing the lighthouses it will be desirable to re-state a few of the principles of lighthouse optics.

Three laws govern the change of direction in the incident light produced by refraction—

1. Incidence and refraction in a structure such as glass occur in a plane perpendicular to the refracting surface.

2. The sines of the angles of incidence and refraction have a fixed ratio, called the index of refraction, and a ray of light falling normally on a surface suffers no refraction.

3. The effect on a ray of light passing from air into glass is to make the angle of refraction less than the angle of incidence, and the converse takes place on passing from glass into air.

A ray of light passing from glass into air has its angle of refraction greater than its angle of incidence, and there is some angle of incidence whose angle of refraction is greater than a right angle. Beyond this no refraction can take place, and a ray is totally reflected.

The index of refraction of glass is about $\frac{3}{2}$. This index is usually represented by the letter μ, and is equal to the sine of the angle of refraction divided by the sine of the angle of incidence $= \frac{\sin r}{\sin i}$. If, therefore, the incident ray makes a greater angle than about 42° with the normal, total reflection takes place. A ray of light passing through a plate of glass with parallel surfaces emerges parallel to its original path, suffering displacement only.

When a ray passes through a triangular prism it is bent towards the base of the prism.

The plano concave, double concave and double convex lenses need not here be considered, the plano convex being the one almost universally used in lighthouse apparatus.

Digitized by Google

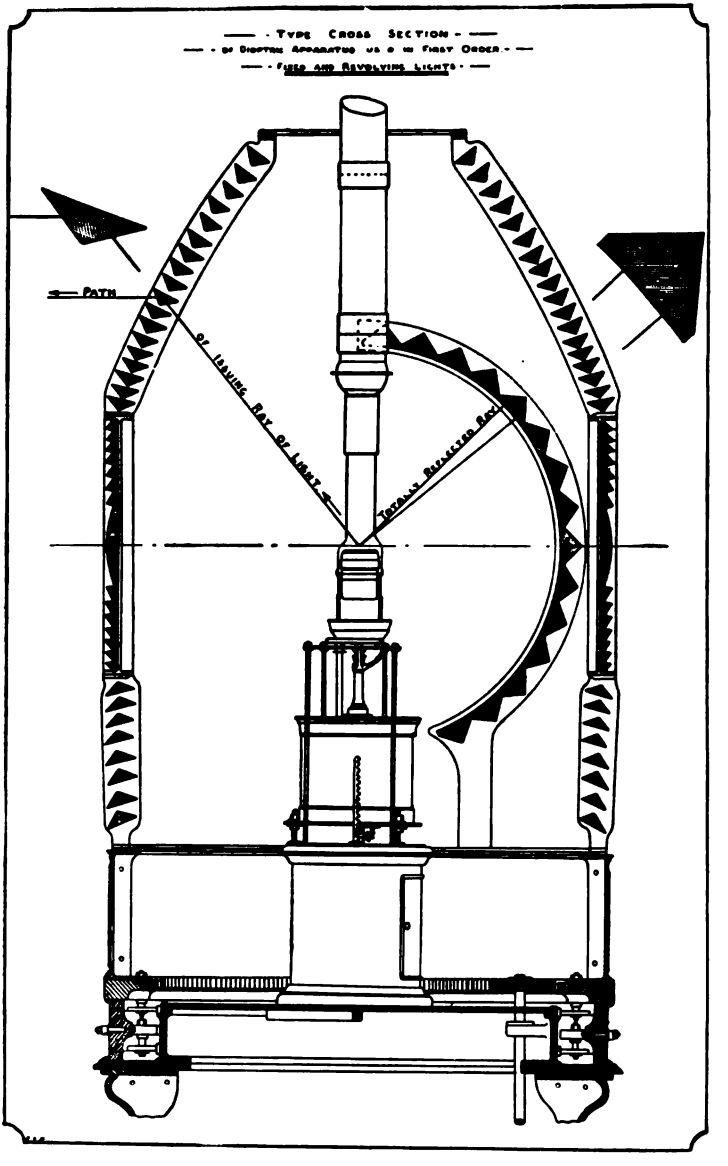
The optical axis is the line in which a ray of light passes unchanged in direction through a lens, and the principal focus is the point from whence rays of light proceeding in a divergent course are so changed by refraction at the inner and outer surfaces of a lens that they emerge parallel to the optical axis. The position of the principal focus in a plano convex lens is found by the formula $F = \frac{r}{\mu - 1}$, in which r = the radius of curvature of the lens, and μ the index of refraction, or it can be found by exposing the lens to the sun. As spherical lenses only parallelise those rays which are incident near the axis, this has led to the building of lighthouse lenses in separate pieces

The Diagram shows a vertical section through the focus of a first order dioptric fixed light.

The focal distance determines the order of light. The focal distance of a first order light is 36·22 inches: the width of the central disc is 11 inches: the annular rings which surround the disc vary in width from $2\frac{3}{4}$ to $1\frac{1}{4}$ inches, and are so arranged that the lenses shall be as nearly as possible uniform in thickness, and thus equalise the absorption. They are 20 in number, placed half above and half below the central disc. Below these zones are six triangular rings of glass ranged in cylindrical form, and above are thirteen rings diminishing in diameter as they recede from the optic axis, thus forming a dome which completes the apparatus.

Three or four problems in lighthouse optics will embrace sufficient of the subject to enable us to trace the path of a ray in any part of the apparatus before it leaves the lighthouse. The approximate solution of these problems, in which the curves are assumed to be circular arcs are given in Fresnel's work on lighthouses, and have been taken from that book, but the author also submits what he believes to be a rigid solution in the case of the path of a ray through the upper and lower triangular prisms, in which the issuing rays of light are twice refracted and once reflected. Fresnel, in dealing with the approximate solution of this problem, assumes that the refracting sides of the triangular

Digitized by Google

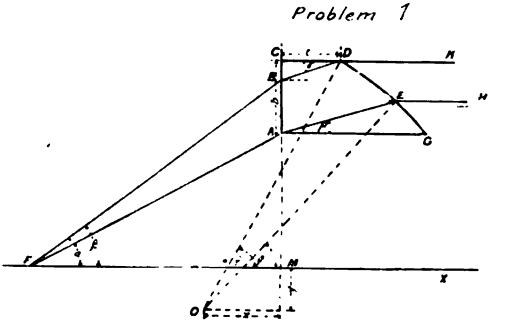


Digitized by Google

prisms are right lines, but in the process of grinding the prisms, it is found convenient for the workmen to give a curved form to the refracting sides, the one being made convex and the other concave; so that both being ground to the same radius (about four metres), the convergence of the rays produced by the first shall be neutralized by the divergence caused by the second. The author has also obtained an expression for the direction of the tangent to the curve at any point in the case of the plano convex lens, but so far has been unable to integrate this expression, and he asks those members of the section interested in the subject to assist him.

PROB. 1.

To find the section of a refracting zone or straight prism.



APPROXIMATE SOLUTION.

ACDG is the section; F, the radiant point; FX a perpendicular to the side CA produced.

OD, OE, normals to the circular arc bounding the prism, and making the angles ψ and ϕ with FX.

α and ρ the angles of incidence and refraction at A.

β and σ ,, ,, ,, B.

$FM = f$; $CD = t$; $AC = b$;

and $b = f(\tan \beta - \tan \alpha) + t \tan \sigma$.

$\mu \sin \rho = \sin \alpha$

$\mu \sin \sigma = \sin \beta$

Digitized by Google

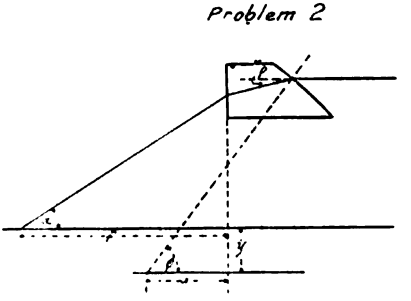
$$\tan\ \phi = \frac{\mu \sin \rho}{\mu \cos \rho - 1}\ ;\ \tan \psi = \frac{\mu \sin \sigma}{\mu \cos \sigma - 1}$$

$$r = \frac{(b - t \tan \rho) \cos \rho}{2 \sin \tfrac{1}{2}(\psi - \phi) \cos \left[\tfrac{1}{2}(\psi + \phi) - \rho\right]}$$

$$x = r \cos \psi - t\ ;\ y = r \sin \psi - f \tan \beta - t \tan \sigma$$

PROB. 2.

Having found the centre of curvature by the preceding formulæ,—to determine the path of any ray.



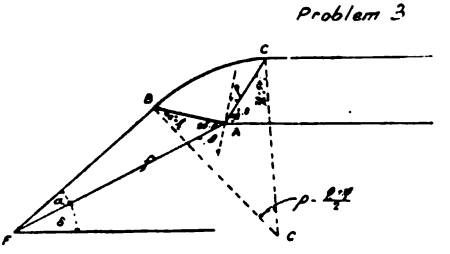
$$\sin \phi = \mu \sin (\phi - \rho)$$

$$\mu \sin \rho = \sin\ \alpha$$

$$\tan \phi = \frac{\mu \sin \rho}{\mu \cos \rho - 1}$$

PROB. 3.

Prism giving two refractions and one reflection.



Digitized by Google

ρ and ϕ = angles of refraction at A and B.

ψ = angle of internal incidence of emerging ray CG.

FA = f.

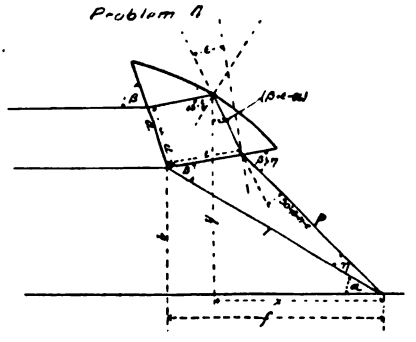
$\sin \theta = \mu \sin (2\theta + \delta - 90°)$.

From this equation find θ by trial.

$\mu \sin \rho = \sin \theta = \mu \sin \psi$.

Prob. 4.

To find equation to true curve of reflecting side of a triangular prism (two refractions and one reflection)



$$t = \frac{l \sin \eta}{\sin (\beta + \eta)}$$

$$p = \frac{l \sin \beta}{\sin (\beta + \eta)}$$

$\cos (\beta + \eta) = \mu \sin \epsilon$ and $\tan (\beta + \epsilon - \alpha) = \dfrac{x - p \cos (\eta + \alpha)}{y - p \sin (\eta + \alpha)}$

$y = b + (a - ct) \sin \beta + [(a - ct) \cos \beta + (f - x)] \times \tan (\beta - \alpha)$.

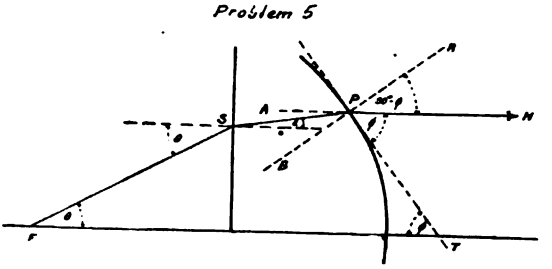
Mean difference in length of sides of reflecting prisms of a 1st order light = $2\frac{3}{4}$ per cent.

The only assumption made, and one which appears to be legitimate, is that the rays of light which fall on the first refracting side are proportionately distributed over the second refracting side.

Digitized by Google

PROB. 5.

PLANO-CONVEX LENS.



Let F be the source of light.

P, a point on curve.

FT, the horizontal axis of lens.

ϵ = angle of refraction at plane surface.

$90° - \phi$ = angle of refraction at curved surface,

ϕ being angle of inclination of tangent at P to horizontal.

$APB = RPH = 90° - \phi$

$APS = \epsilon$

$\therefore SPB = 90° - \phi - \epsilon$

and $\sin RPH = \mu \sin SPB$

i.e., $\sin (90° - \phi) = \mu \sin (90° - \phi - \epsilon)$

or, $\cos \phi = \mu \cos (\phi + \epsilon)$ (1)

Also $\sin \theta = \mu \sin \epsilon$ (2)

From (1): $\cos \phi = \mu \cos \phi \cos \epsilon - \mu \sin \phi \sin \epsilon$ and substituting from (2)

$$\cos \phi = \mu \cos \phi \sqrt{1 - \frac{\sin^2 \theta}{\mu^2}} - \sin \phi \sin \theta$$

$$\cos \phi = \cos \phi \sqrt{\mu^2 - \sin^2 \theta} - \sin \phi \sin \theta$$

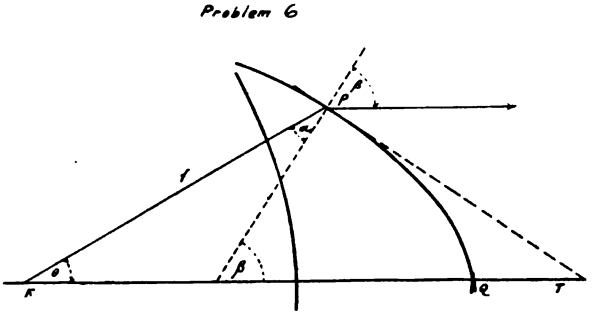
$$1 = \sqrt{\mu^2 - \sin^2 \theta} - \sin \theta \tan \phi$$

$$\tan \phi = \frac{\sqrt{\mu^2 - \sin^2 \theta} - 1}{\sin \theta} = \frac{dy}{dx}$$

Digitized by Google

PROB. 6.

SPHERICAL LENS.



Let F be the source of light.

Let P be a point on the outer curve,

and FT, the horizontal axis of lens.

a = the angle of incidence on outer curve.

β = the angle of refraction from outer curve.

The inner curve is described from F as centre, with radius depending on size of lantern.

Required the equation to outer curve.

$B = \theta + a$

and $\sin \beta = \mu \sin a$

$\therefore \mu \sin a = \sin (\theta + a)$ (1)

$FPT = \psi = \frac{\pi}{2} + a. \quad \therefore a = \psi - \frac{\pi}{2}$

and from (1) $\mu \sin \left(\psi - \frac{\pi}{2}\right) = \sin \left(\theta + \psi - \frac{\pi}{2}\right)$

$\therefore \mu \cos \psi = \cos (\theta + \psi)$

$= \cos \theta \cos \psi - \sin \theta \sin \psi$

$\therefore \mu = \cos \theta - \sin \theta \tan \psi$

$\therefore \tan \psi = \frac{\cos \theta - \mu}{\sin \theta}$

But $\tan \psi = r \frac{d\theta}{dr}$

Digitized by Google

$$\therefore \quad r \frac{d\theta}{dr} = \frac{\cos\theta - \mu}{\sin\theta}$$

$$\therefore r \sin\theta . d\theta = dr.(\cos\theta - \mu)$$

$$\therefore \frac{dr}{r} = \frac{\sin\theta}{\cos\theta - \mu} d\theta$$

and integrating $\int \frac{\sin\theta}{\cos\theta - \mu} . d\theta = \int \frac{dr}{r}$

$$= \log r + \log C \quad \ldots \quad (2)$$

where C is an arbitrary constant.

and from (2)

$$-\log(\mu - \cos\theta) = \log(r\,C)$$

$$\therefore r\,C = \frac{1}{\mu - \cos\theta}$$

$$\text{and } r = \frac{C}{\mu - \cos\theta} \quad \ldots \quad \ldots \quad (3)$$

which is the equation to the curve, C being an arbitrary constant depending on the radius of the lantern, and the thickness of glass at centre.

If $FQ = a$

i.e., $r = a$ when $\theta = o$

we have from (3)

$$a = \frac{C}{\mu - 1}$$

i.e., $C = a(\mu - 1)$

and the equation becomes

$$r = \frac{a(\mu - 1)}{\mu - \cos\theta} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

When investigating the nature of the curvature of the different prisms used in the dioptric apparatus of our lighthouses, it seemed to the Author that as in none of the prisms used were there less than two refractions, if the number of refractions could be reduced, a saving in light could be effected. It is possible to reduce the number of refractions to one by making the inner surface of the lenses spherical in form, the radiant point being the centre from which the sphere is described. The issuing rays of light will then strike the inner surface normally, and consequently there will be no refraction at this surface.

Digitized by Google

It remains, therefore, to determine the form of the outer surface, so that all rays emerging from the glass shall be bent into a horizontal or any other required direction.

The equation to this curve is $r = \frac{a(\mu-1)}{\mu-\cos\theta}$ where r = the radius vector, a, the value of r, when θ = o, θ the vectorial angle, and μ the index of refraction.

Description of Path of Rays in Dioptric Apparatus.

In the dioptric apparatus the path of a ray issuing from the light through the central lens is twice refracted, and, generally speaking, emerges in a direction parallel to the optical axis. The same occurs on the passage of a ray through the annular zones, which are merely portions of a larger lens with the central portion cut away to reduce the thickness of the glass. The path of a ray through the triangular prisms is first refracted, then reflected, and then again refracted in such a manner as to emerge in a direction parallel to the optical axis. The paths are illustrated on the diagram. In holophotal lights the rays which emerge to the back of the focus are reflected back again through the focus by prisms having their inner faces normal to the outward and backward rays, and their outer surfaces constructed to such curves as to cause the rays to be twice reflected and thrown back through the focus on to the forward lenses and triangular prisms.

If the section shewn on the diagram revolve round a vertical axis passing through the focus, it will generate the cage which is used in a fixed light, and if the same section revolve round a horizontal axis passing through the focus it will generate the apparatus used in revolving lights, but the extent of the revolution in this case is governed by the number of sides it is intended the cage shall have.

Comparison of Dioptric and Catoptric Systems.

The superiority of the dioptric over the catopric system is, of course, well established, but the following, taken from Stevenson's work, gives a measure of their relative values:—"From experi-

Digitized by Google

ments made on silver plate of the kind used in lighthouse apparatus, it was found that at 45° incidence only ·556 of the incident light was reflected, and from experiments made with a reflecting prism of glass, it was found that the amount of light transmitted was ·806 of the whole, which shews that by using glass a saving of one-fourth is effected, and establishes the superiority of glass over metal for lighthouse purposes."

The catoptric mirror is formed by the revolution of a parabola about its axis, and if a light be placed in the focus of the paraboloid so generated, all the incident rays will be reflected in a direction parallel to the axis from the well known property of the parabola, that if from a point on the curve lines be drawn to the focus and parallel to the axis, these lines will make equal angles with the tangent at the same point.

The dioptric system was invented by Augustus Fresnel in France in 1822, and the first light on this principle was that of Cordouan at the mouth of the Garonne. It was introduced into England in 1835 by Mr. Alan Stevenson.

In 1845 M. Leonor Fresnel reported to the American authorities that lights fitted with dioptric apparatus were incontestably superior to those fitted with catoptric apparatus, that if we take into account the first cost and maintenance we find in respect of the effect produced, the new system is from one and a half to twice as advantageous as the old, and in 1852 the American Board resolved that the Fresnel—or lens system modified in special cases by the holophotal apparatus of Mr. Thos. Stevenson—be adopted as the illuminating apparatus of the United States to embrace all new lights now or hereafter authorised, and all lights requiring to be renovated by reason of deficient power or defective apparatus.

Description of New South Wales Lighthouses.

There are twenty coast lighthouses, twelve of the larger class of harbour lights, and two lightships. Six of the coast lights are of the first order dioptric, viz.:—Green Cape, Montagu Island, Macquarie (South Head), Sugar Loaf (Seal Rocks), Smoky Cape

Digitized by Google

(Trial Bay), and South Solitary Island. Five of these are revolving, and one fixed and flashing. There is one second order dioptric fixed, seven fourth order dioptric fixed, and six catoptric, two of which are revolving and four fixed. A table of these is appended and their position on the coast is shown in the accompanying map.

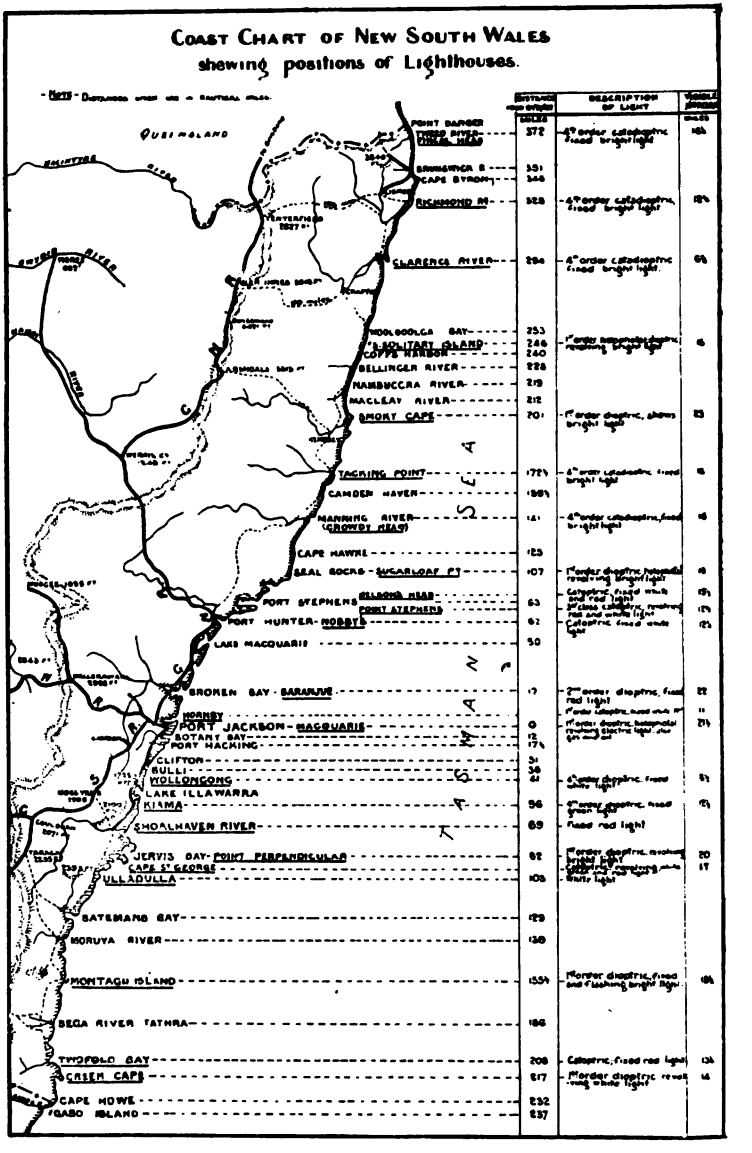
The distance in nautical miles from Green Cape to Montagu Island is 62 miles, from Montagu Island to Jervis Bay 73, from Jervis Bay to Macquarie Lighthouse 82, Macquarie to Seal Rocks 107, Seal Rocks to Smoky Cape 100, Smoky Cape to South Solitary Island 39. The average distance between these six main coast lights is therefore 77 miles. The distance from South Solitary Island lighthouse to Cape Byron, the most eastern point of Australia, is 99 miles, which points to the necessity of establishing a first-class light at Cape Byron.

There is so much that is similar in many of these twenty lighthouses that the author fears reading a description of each would tax the patience of members of the Section beyond reasonable endurance. He has therefore placed the particulars of all the lights in tabular form in their order from South to North, and believes this arrangement will prove more convenient for those members who may desire information concerning the lighthouses, quarters, etc. (Appendix II)

Means of Illumination.

The cylindrical-wick lamp in its various forms is the usual mode of lighting employed in lighthouses, gas and electricity being also used. For small lights and the lamps of parabolic reflectors, the burner is about an inch in diameter, but for the more powerful lights the burner consists of a series of concentric wicks, two or more in number, with intervening air spaces, and the largest burners have concentric wicks up to ten in number. In the larger lamps the light can thus be adjusted to suit the weather by lighting or extinguishing one or more of the rings. The burners in general use are five and six wick. The outer diameter of a six-wick burner is $4\frac{3}{4}''$; of a seven-wick $5\frac{1}{8}''$. The height of the

Digitized by Google



Digitized by Google

flame is about six inches, and great heat is given off, special care being necessary to prevent breakage of the glass chimney. Mineral oil is chiefly used in New South Wales, and the oil is made to flow into the burners by various means. Fresnel's invention consisted of four small pumps worked by clockwork which forced the oil upwards to the flame. Other modes are by weights acting on a piston, by a spring doing the same office, in the pneumatic lamp by means of the pressure of air in the reservoir, and another plan is by placing the reservoir slightly higher than the lamp, the oil thus flowing freely by gravity to the required level.

Characteristics.

The increase of lights naturally leads to the necessity of distinction between them. What is required is a well defined and easily recognised light. The main distinctions are Fixed and Revolving. Fixed, though less powerful than Revolving, is a useful distinction, as coloured sections can be shown from it to indicate dangers in the neighbourhood. With a Revolving light this cannot be effected, but Revolving lights are more distinctive than Fixed lights, the alternations of light and darkness are so marked as to strike the most careless observer. The tendency of late has been in the direction of shortening the interval of darkness, very few of the longest periods being now more than a minute, for with the increased speed of steamships a considerable distance might be traversed before the full character of a long period light could be made out. The characteristics in use are:— 1. Fixed. 2. Revolving light, gradually increasing at equal periods to full power, and then gradually decreasing to eclipse. 3. Fixed lights, varied by flashes; shows a fixed light which at certain periods is varied by white or coloured flashes. 4. Flashing, shows a single flash at intervals of a few seconds. 5. Group Flashing, shows groups of two or more flashes in quick succession, separated by a period of eclipse between the groups. 6. Intermittent, which bursts instantaneously into full power, and, after remaining for a period as a fixed light, is suddenly eclipsed.

Digitized by Google

7. Alternating lights of different colours, generally white and red alternately. 8. Double lights.

Revolving Gear for Lighthouse Apparatus.

This is a clockwork motion, the motive power of which is a heavy weight suspended and working through a wrought iron tube in the centre of the tower. The cage itself revolves upon and is supported by a roller base, consisting of a series of small rollers, kept equidistant, which revolve round the centre, and on their own spindles, thus reducing the friction to a minimum. The gear is fitted with a governor to regulate the speed of rotation, and is of the conical pendulum centre weight type. The centre weight consists of a metal disc connected to the governor arms, and the lift and speed is regulated by two set screws projecting from the main framing. The motion can also be stopped at any time by means of a similar set screw which can be made to press on the edge of the disc. The weights, which are suspended by a pulley from an endless chain, are wound up periodically according to the speed of rotation of the cage, the act of winding having no effect upon the revolving gear. In case of accident or repair to the gearing, the cage can be disconnected and caused to revolve by manual power from a winch handle.

Cost.

The total capital expenditure on the Lighthouses up to the present has been about £200,000, and the present annual cost of attendance, stores, &c., about £11,500. The total expenditure on repairs and maintenance and additions during the last forty years has been £24,000.

The design, construction, maintenance and repairs of the Lighthouses were originally under the Colonial Architect, Mr. Barnet, but were transferred to the Harbours and Rivers Department in 1889, and placed under Mr. Cecil W. Darley, M. Inst. C.E., the present Engineer-in-Chief for Public Works.

Digitized by Google

New Lighthouse, Point Perpendicular.

It has long been known that the Cape St. George Lighthouse was not erected in the most suitable position, and a lighthouse is now in course of erection at Point Perpendicular which, when completed, will take the place of the Cape St. George Lighthouse. This establishment, a description of which will serve as a type, consists of a lighthouse with quarters for a principal lightkeeper and two assistant keepers, with all the necessary storerooms, workrooms, stabling, cartshed, and other outbuildings, also a flagstaff and flag house for signalling purposes. The site of the lighthouse is situated in Lat. 35° 5′ 5″ S., Long. 150° 50′ 0″ E. on the extreme point of Point Perpendicular, distant about 150 feet from the edge of the cliff, which is here 284 feet above H.W., and has a sheer vertical face with deep water at the foot.

A service road has been cut and formed from the lighthouse site to a sheltered Bay in Montagu Road, Jervis Bay, distant about five miles, where a jetty 200 feet long and 12 feet wide is constructed with turpentine piles and hardwood girders and decking. The jetty is L shaped and has at its outer end a depth of nine feet at L.W. It is sheltered from all but the west and north-westerly winds, so that goods and passengers can be landed safely. A lock-up storeroom is provided adjacent to the jetty so that goods landed may be left in safety until it is convenient to transport them to the lighthouse. The storeroom is 15′ x 12′, and 9′ high, and is constructed of hardwood framing, and the walls covered with tallow wood weatherboards of special design. The roof is covered with red tiles and the floor is laid with stout tallow-wood boards. The building is raised on concrete blocks to a height of two feet from the ground, the space being left open for ventilation. The rain water from the roof is collected and stored for use of persons who may be detained at the wharf.

The lighthouse establishment is situated on a level plateau with but little depth of surface soil, so no difficulty is experienced in obtaining a solid rock foundation for the whole of the walling, and advantage has been taken of the abundance of good, hard, coarse sandstone in the immediate neighbourhood to construct

Digitized by Google

the building, as far as possible, of concrete; the walling throughout being of concrete blocks cast in moulds of suitable size and shape to the various portions of the work, mostly in courses 12″ high. These blocks, when moulded, are cemented on all external faces, then stacked until fit for use, when they are set in the same manner as is used for ordinary stonework, being bedded and jointed with cement mortar and having a margin of painters' putty on the outer edge of all beds and joints. This class of work, while novel to the colony, is largely used in other parts of the world, and has the advantage of obviating the disfiguring cracks caused by shrinkage of material usually seen on the faces of structures built with mass concrete.

Lighthouse Buildings.

The lighthouse buildings proper comprise the tower with entrance lobby and porch, and two large rooms for use as store and workrooms. They face the south-east, the tower being in the centre and having half its diameter clear in advance of the rest of the buildings, the work and storerooms being on either side with the lobby and porch in the central rear. The tower is 11′ 9″ diameter in the clear inside, and 44′ high from the ground to top of walling. It stands on a footing of mass concrete let into the rock as far as is necessary to insure solidity, the external face of walls rising from a bold moulded face and with a concave batter to the top, which is fitted with a massive cornice supporting the projecting gallery round the outside of the lantern. The tower is divided into three stories by concrete floors, 12″ thick, the level of the lowest floor being kept up 3′ above the ground. Access to the various floors is gained by staircases 3′ wide extending from floor to floor, constructed of concrete blocks built in as the work proceeds, and fitted with rubbed slate treads, similar slate being fitted round the margin of all well holes, the treads being fixed with strong brass screws for the convenience of renewal when worn. The handrail to all staircases is of 2″ heavy brass tubing, the balusters are of ornamental wrought iron, and the newels are of cast iron. All the

Digitized by Google

concrete floors are paved with small black and white tiles, and the internal face of tower walls, together with the concrete ceilings and staircase, are smoothly rendered with cement and decorated with paint work. The various windows, six in number, which are necessary to light up the floors of the tower, are small in size, and are made very strongly of gun-metal castings to a perfectly waterproof design, and glazed with polished plate glass, $\frac{3}{8}$″ thick.

The entrance lobby on the ground floor is 10′ long 6′ wide and 12′ high, having a tile floor and cedar entrance door with embossed plate glass panels and side lights opening from a porch, 6′ x 6′, which has an open entrance and side windows, and is paved with trachyte, and has a flight of trachyte steps. The storeroom and workroom are each 18′ x 15′, situated on each side of the entrance lobby, and entered from the same by cedar doors. These rooms are 12′ high, and are roofed over with flat concrete, 12″ thick, supported where necessary on rolled iron girders. The flat roof thus formed over the whole area of store and work rooms, lobby and porch is paved with Val de Travers asphalt, and is entered from a door opening from the first door of the lighthouse tower, the door being protected from the weather by wing walls and roof of concrete, and the whole is surrounded by embattled parapet walls 4′ high, ample provision being made by surface gutters and down pipes for removing the heaviest downpour of rain. The internal walls and ceilings of all these rooms are cemented, the walls are painted, and, together with the tower, have a sunk dado moulding. The lower portion, or dado, being painted a darker colour and varnished. The outer walls of this block of buildings are finished with channelled joints to all concrete blocks in plain wall surfaces, and a bold splayed battered plinth and a massive cornice with plain fascia and architrave moulding is carried all round; the whole being painted in plain colours. The floors of the store and workrooms are paved with Val de Travers asphalt, the windows are of cedar, having the lower portions fixed and the upper portions made to open as fanlights with strong brass

Digitized by Google

fanlight openers. These rooms are fitted up with strong pine shelving for lamp glasses and other stores, strong stands for oil tanks, work table with drawers and shelves, and a wash sink with pump connected with an underground rain-water tank of 3,000 gallons capacity, having a manhole with raised trachyte kerb, and galvanized wrought iron cover and wrought iron foot holds built into the tank walls for access. The tank is sunk in the solid rock and lined all round the walls with mass concrete 12″ thick, and the floor with concrete 9″ thick, the roof being formed with flat concrete 12″ thick flush with the surface of the ground, the whole being carefully rendered with cement inside. A margin 6″ thick and 6′ wide is put all round this building at the ground level, and having a fall from the walls outward rendered with cement to protect the foundations of the buildings.

At the top of the tower the lantern room is surrounded by an open gallery with a clear space all round, 4′ 4″ wide, the floor of which is of trachyte 16″ thick, in sixteen stones with radiating joints and moulded outer edge. The upper surface of these stones or floor of gallery is paved with Val de Travers asphalt to prevent any soakage of water into the walls below. The outer edge of the gallery is protected by a parapet wall of trachyte 3′ 6″ high, having a moulded coping and panelled front. The whole of the trachyte work is strongly put together with copper cramps and dowels in all joints, and the floor stones are bolted down to the tower walls with wrought iron rods. The lantern room with its floor and domed roof, also the lantern and illuminating apparatus weighing altogether about 33 tons, have been manufactured by Messrs. Chance Brothers & Co., to the order of the New South Wales Government, and have been imported at a cost of nearly £4,000, and are not included in the contract now let for the buildings, the contractor for which, however, has to convey them from Sydney and erect them in position.

The lantern room is circular in plan, 12′ 1½″ clear diameter inside. The floor is of wrought iron chequered plate supported

Digitized by Google

on rolled iron girders. The walls are of cast iron to a height of 7′, lined on the inside with sheet iron, the space between inner and outer surfaces being utilised for the admission of fresh air to the lantern, gratings being placed at intervals on the outside, and brass hit and miss grating on the inside for regulating the quantity and direction as required. Above the cast iron base is an open framework 10′ 3″ high, having astragal bars paved with polished plate glass $\frac{3}{8}$″ thick in lozenge-shaped squares, so that no vertical bars can obstruct the beam of light. A cast iron gallery supported on cast iron ornamental brackets is carried round the lantern both inside and out at the base of the glazed framing to facilitate cleaning operations, the gallery has perforated cast iron floors and light wrought iron handrail for protection, and is accessible by means of short flights of step ladder of wrought iron. The lantern room is roofed by a dome having sixteen cast iron ribs covered inside and out with strong copper sheeting, and surmounted by a strong copper ventilator, 6′ diameter, with a weather vane in the centre which, acting upon a dial visible in the room beneath, indicates to the keeper on duty the direction of the wind, and so enables him to regulate the admission of fresh air.

The apparatus itself is of prismatic glass in gun-metal framing, nine sided with concave sides. It is about 6′ diameter and 9′ high, partially domed or contracted at top to a diameter of 2′ 3″. It is a first order dioptric revolving white light, triple flashing every 20 seconds, and making one complete revolution each minute and a half. The apparatus is attached to a cast iron base or carriage fitted with a gun-metal toothed driving wheel, and revolving on conical steel rollers, the driving wheel being operated on by a gun-metal driving pinion worked by a clock-work arrangement of steel and gun-metal, the motive power for which is obtained by weights suspended on chains working in a wrought iron tube 16″ diameter passing through the whole height of the tower, and having doors for access on each floor. Should any accident occur to this machinery provision is made for continuing the revolution of the lantern by hand gear.

Digitized by Google

The height of the focal plane above the ground will be 56′, and above H.W. 304′, the visible horizon at this level being 23½ miles.

Due south of the lighthouse and distant 100′ therefrom is the Signal Station. The flagstaff is within 60′ of the edge of the cliff. It is 60′ from the ground to the top of the truck, and consists of a mainmast, topmast and four radiating spars with the necessary rigging. The flag house is situated 25′ to the eastward of the flagstaff. It is a circular structure 6′ in diameter, built with concrete blocks and cemented inside. The roof is of concrete and conical in shape, slightly concave on its outer surface. The roof terminates at the eaves with a moulded cornice and at the apex with a cast cement ball terminal. Provision is made for ventilation by gratings, and the house is fitted up with 39 pigeon holes, each 12″ x 12″ x 9″, to hold the signal flags, and there is also a small fixed table.

QUARTERS.

The keeper's quarters are situated due south of the lighthouse and distant about 70′ to the nearest point. The buildings are constructed throughout of concrete blocks on mass concrete foundations. The roofs are framed of hardwood covered with red tiles of the French pattern, manufactured by Messrs. Goodlet and Smith, of Granville, each tile being secured to the roof timber by a loop of strong copper wire. The external walls are plastered throughout, and have cement polished skirtings. A fireplace is provided to each room, and these are lined throughout with colored glazed bricks and finished with cement mouldings and slate mantels and hearths. An underground rain water tank, similar to that described for the lighthouse building, but capable of holding 6,500 gallons, is supplied to each house with a brass-barrelled lift pump and sink inside the scullery. The verandah and laundry floors throughout are paved with Val de Travers asphalt on concrete, and they are roofed with tiles. Each cottage has a fair allowance of garden ground enclosed by concrete block walls 7′ high, and having concrete paths and edging to the soil beds, the soil for which to a depth of 18″ is carted from a

Digitized by Google

distance. The entire area enclosed for the three houses is 203′ x 130′, all in one block, the front fence wall being rather lower and finished with an iron railing on top. Earth closets are provided to each house, and a stable with coachhouse and workroom for carpenters or other work. The rain water from the roofs of these buildings is collected in three 400 gallon tanks. The drainage from the buildings is carried away in stoneware drain pipes, discharging over the face of the cliff where they are fitted with cast iron bends turned downwards. Inspection pits fitted with raised trachyte kerbs and wrought iron manhole lids are placed at intervals along the line of pipe, and doors are fitted to the pipes at certain portions to allow of a collection of waste water in the higher levels of the pipes which can be suddenly discharged for flushing purposes. Ventilating pipes for foul air are connected with the drains and taken up to discharge above the roofs of cottages.

The entire premises are enclosed from cliff to cliff on the N.E. and N.W. sides by a paling fence 6′ high, and a fence is also placed along the edge of the cliff. A three-rail fence is also put across the promontory from cliff to cliff, enclosing an area of about 80 acres to provide pasturage.

The whole of the detail plans, specification, bill of quantities containing 400 items, and the estimate, have been prepared by Mr. Charles Harding, the architect in charge of lighthouse design in the Public Works Department, under the direction of Mr. C. W. Darley, M. Inst. C. E., Engineer-in-Chief for Public Works, and are so complete that Mr. Darley has decided to adopt them as the standard for lighthouse work in the future. Mr. Harding's estimate of the cost of the work was £10,266 5s. 8d., and a tender has been accepted for £10,719 16s. 10d., which shows remarkable care and accuracy when the isolated position and difficulty of access to the lighthouse is taken into consideration.

A sum of money has been placed on the estimates for the construction of a first order lighthouse and equipment at Cape Byron, 17 miles north of the Richmond River, the most eastern point of Australia.

Digitized by Google

APPENDIX I. PARTICULARS OF LIGHTHOUSES

No.	Lighthouse and Date of Construction.	Latitude and Longitude.	Description of Light.	Height of focal plane above high water mark	Visible Horizon in nautical miles.	Keepers. No.	Keepers. Annual Salaries	Cost of Erection
1	Green Cape. 1883.	37° 15″ 7′ S. 150° 4′ E.	1st order djoptric; revolving white light, flashing every minute; visible between S. ¼ W. and N. ¾ W.	144 ft.	14	3	£508	£19..
2	Twofold Bay, 1862.	37° 4′ 5″ S. 149° 55′ 6″ E.	Catoptric; fixed red light, visible seaward between N. 39° E. and S. 62° E.	133 ft.	13½	Pilot	£160	£1..
3	Montagu Island, 1881.	36° 15′ 3″ S. 150° 14′ 5″ E.	1st order dioptric fixed, and flashing bright light; fixed for 33 seconds, then a flash of 5 seconds, between two intervals of 16 seconds darkness.	262 ft.	18½	3	£483	£22..
4	Ulladulla, 1873	35° 22′ 3″ S. 150° 31′ 3″ E.				1	£150	£5..

Digitized by Google

COAST OF NEW SOUTH WALES.

DESCRIPTION OF BUILDINGS.

Tower.	Quarters.
d on the extremity of Green or Bundoora Disaster Bay. Tower is 68 feet high from to floor of lantern, divided into 4 stories. ith concrete mass walls, cemented inside t. Iron staircases and floors. Bluestone round lantern, with gun-metal railing. il store attached to tower, also built of e, with domed concrete roof. Detached id workroom is also provided, of similar ction to quarters.	Quarters are provided for head keeper, containing 5 rooms, with kitchen and storeroom, also a room for visiting officers; and quarters for 2 assistant keepers, each with 4 rooms, kitchen and storeroom; all built with brick walls, cemented outside, and with galvanized iron roof covering. Underground rain-water tanks of 6000 gallons capacity are provided to each house. Stable and cart shed are also provided, and a timber jetty with storeroom at Bittangabee Bay.
d on the southern extremity of Lookout The tower is 28 feet high from ground r of lantern room, built of hardwood on stone foundations, walls being covered lly with weatherboards. Tower 10 feet at base, and 6 feet hexagon in upper , with projecting hardwood gallery round with iron railing, Painted white lly.	Quarters are provided for pilot or harbour master (who has charge of the light), consisting of three rooms with out offices; and also for his boats crew and customs landing waiter, consisting also of 3 rooms with out offices. The quarters are situated at the rear of the tower, and attached to same, and are constructed of hardwood timbers on stone foundations, covered with weatherboards on the outside, and plastered inside. The roofs are covered with ironbark shingles. A verandah 5 feet wide is carried all round the building (except kitchen) supported on wood posts and roofed with galvanized corrugated iron.
d on a large granite boulder on the t of the Island The tower is circular, diameter inside, 40 feet high from top of r to floor of lantern, the boulder being high from the ordinary ground level, by a flight of granite steps. The tower is l into 3 storeys, built with dressed granite 3 feet thick at base, battering to 2 feet at top, with iron staircases and floors. e gallery round lantern, with gun-metal . The oil store is a detached building at the boulder, and is built as described for rs.	Quarters are provided for head keeper, containing 5 rooms, with kitchen and storerooms; also a room for visiting officers, and quarters for 2 assistant keepers, each with 4 rooms, kitchen, and storerooms, all built with brick walls and cemented outside, and with galvanized iron roof covering. Underground and rain-water tanks of 6000 gallons capacity are provided to each house. Stable and cart shed, built of timber, are also provided, and a timber jetty with crane and boathouse at the landing place.
ally situated on the pier at Ulladulla ur. Was removed to Warden Head in The tower is constructed of iron, circular n, 11 feet diameter at ground, diminishing eet diameter at top; 27 feet high from	Quarters were erected in 1890 for 1 keeper at Warden Head, containing 4 rooms and kitchen with out offices, all with brick walls cemented outside, on concrete foundations, and with galvanized iron roof covering. An undergrond

Digitized by Google

PARTICULARS OF LIGHTHOUSES ON TH

No.	Lighthouse and Date of Construction.	Latitude and Longitude.	Description of Light.	Height of focal plane above high water mark	Visible Horizon in nautical miles.	Keepers.		Cost of Erection.
						No.	Annual Salaries.	
	Ulladulla—*Continued*							
5	Cape St. George, 1860.	35° 9′ 3″ S. 150° 47′ 4″ E.	Catoptric; revolving, white, green. and red, alternating every ½ minute.	224 ft.	17	3	£465	£1,3[illegible]
6	Point Perpendicular, 1897 (now building).	35° 5′ 5″ S. 150° 50′ 0″ E.	1st order dioptric; 9-sided, revolving, bright light, triple flashing every 20 seconds, and making 1 complete revolution in 1½ minutes.	304 ft.	20			Contract Amount Building £10,719 Wharf £ Lantern £

Digitized by Google

F OF NEW SOUTH WALES.—*Continued.*

DESCRIPTION OF BUILDINGS.

Tower.	Quarters.
to floor of lantern, divided into 3 stories, rood floors, connected by iron ladders. ot of tower enters the ground to a depth feet, and is bedded in a solid mass of e 9 feet deep.	rain water tank of 6,000 galls. capacity is provided.
d about 1 mile north of Cape St. George. wer is 53 feet high from ground to floor ern, divided into 3 stories. It is circular , 10 feet diameter inside. Walls 3½ feet at base, tapering to 2 feet thick at top. f sandstone, dressed both sides, bedded e mortar. The floors are of wood, and ternal staircases of iron, with a stone se from ground to 1st floor, forming pe to tower. The gallery round lantern of sandstone, with a wrought iron hand- An oil-store is provided in part of quarters g.	Quarters were originally provided for the head keeper, and assistant keepers, in a block of 1 storey buildings round the tower, which rises from the centre of them, 3 rooms being provided for head keeper, and 2 each for under keepers, inclusive of kitchens. The walls are of sandstone, dressed both sides. The roof is of stone flagging laid flat, supported on cast iron girders, and covered on top with asphalt. Additional rooms and verandahs have since been added to this block of buildings, and it is now devoted to the use of the 2 under keepers only; a new weatherboard cottage on hardwood piles, containing 7 rooms, being erected for head keeper in 1877.
d on Point Perpendicular, Jervis Bay. wer is 44 feet 4½ inches high from ground of lantern, divided into 3 stories. It is r in plan, 11 feet 9 inches diameter Walls 3½ feet thick at the base, g with a concave batter to 2½ feet thick . Built of concrete blocks, bedded in mortar, the beds being crossed with a fillet; the faces of walling are cemented and out; the floors are of concrete, with rfaces. The internal staircases are also crete, with slate treads, and having t iron balusters and brass tubular hand- The floor of lantern room is of ironwork. rojecting gallery outside lantern is of le, supported on concrete oversailing and paved with asphalt, and has a le parapet wall. The tower is entered lobby, 10 feet x 6 feet, having a tiled nd outer porch 6 feet square. On each lobby are the workroom and store, each x 15 feet; the floors paved with asphalt. ofs of the stores, lobby, and porch are of te, flat, supported on rolled iron girders, ved with Val de Travers asphalt, a door	Quarters are provided for head keeper in a detached cottage, containing 4 rooms, with kitchen, laundry, and storerooms, also a room for visiting officers; and quarters for 2 assistant keepers in 2 semi-detached cottages, each containing 4 rooms, with kitchen, laundry, and storerooms. The walls are of concrete blocks, cemented outside, and plastered within. The roofs are covered with red roofing tiles, of the Marseilles pattern. Verandahs, 8 feet wide, are put round all principal fronts, paved with Val de Travers asphalt. and roofed with tiles. Underground rain water tanks, of 6,500 galls. capacity, are provided to each house A detached workroom is provided, as also is a 2-stall stable, a coachhouse, and the usual out offices. The fence, walls, enclosing gardens, &c., are all of concrete blocks, and the yards and pathways to houses and gardens are paved with concrete.

Digitized by Google

PARTICULARS OF LIGHTHOUSES ON T

No.	Lighthouse and Date of Construction.	Latitude and Longitude.	Description of Light.	Height of focal plane above high water mark	Visible Horizon in nautical miles.	Keepers. No	Keepers. Annual Salaries.	Cost of Erection
	Point Perpendicular—*Continued*							
7	Shoalhaven, 1882.	34° 51′ S. 150° 47′ E.	Fixed red light.					£80
8	Kiama, 1887.	34° 40′ 4″ S. 150° 5′ E.	4th order dioptric, fixed green light. Red danger, and green on breakwater; lit by gas. Also one fixed green light on extremity of breakwater.	119 ft.	12½	Pilot.	£236	
9	Wollongong, 1872.	34° 25′ S. 150° 55′ 5″ E.	4th order dioptric, fixed white light, shewing between NNE and E by S½ E. A fixed red light is shewn from NE side of lighthouse, where it is dangerous to to enter the harbour.	56 ft.	8½	Pilot.	£215	£2,25
	Macquarie (Old), 1817.	33° 51′ 2″ S. 151° 18′ 3″ E.	3rd order catadioptric, white light.	346 ft.	21½			

Digitized by Google

ST OF NEW SOUTH WALES.—*Continued.*

DESCRIPTION OF BUILDINGS.

Tower.	Quarters.
ıt floor of tower opening on to same. A ;in of concrete paving, 6 feet wide, is put ɔund the outside of the building, and an rground rain water tank of 3,000 galls. city, with pump, &c., is provided for the ɔf the workroom, &c. A timber wharf and room are also provided at the landing).	
ıted on the north point of entrance.	
ıted on the hill above Blowhole Rock. The r is 38 feet high from ground to floor of ırn, divided into 3 storeys, with wood floors iron ladders Circular on plan, 5½ feet ıeter inside, with brick walls 2½ feet thick e bottom, battering to 1½ brick thick at top, feet diameter externally at base, tapering to eet diameter at top, having a gallery of ıed freestone round lantern, with iron ıg. The foundations of tower are of rete. Gas laid on from town supply.	Quarters are provided for 1 keeper, containing 4 rooms and out offices. The walls are built of brickwork, cemented outside, and plastered inside, on concrete foundations, and roofed with galvanized corrugated iron. Verandah on one front. An underground rain water tank, of 6,000 galls. capacity, is provided.
ıted on end of breakwater. The tower is eet high from the ground to the floor of ırn, constructed throughout of iron, circular ılan, 13½ feet diameter at foot, diminishing concave batter to 8 feet diameter at top; led into 3 storeys, with wood floors, con- ed by iron ladders, the bottom one being on ɔutside, giving entrance to the tower on the loor. The lantern has an outer gallery of with iron railing. The foot of tower ds on a base of dressed stonework, and is ned to the ground by 12 wrought iron ıor rods, each 2 inches diameter and 12 feet , having large washer plates; the whole ed in a mass of concrete 12 feet deep.	No quarters provided.
ated on South Head of Port Jackson Taken n in 1883. The tower was 58 feet high ı ground to floor of lantern, divided into 3 es, the lower floor being domed over with rwork, and utilised as an oil store. Circular lan, 11 feet diameter inside, built of dressed	Quarters were provided for 2 keepers in 2 wings, each about 24 feet square, one on either side of tower and attached to same. These wings being 2 stories high, with 1 room on each floor, and entrance lobbies, staircases, landings, &c. The bedrooms on upper floor were surmounted

Digitized by Google

PARTICULARS OF LIGHTHOUSES ON T

No.	Lighthouse and Date of Construction.	Latitude and Longitude.	Description of Light.	Height of focal plane above high water mark	Visible Horizon in nautical miles.	Keepers.		Cost of Erection.
						No.	Annual Salaries.	
	Macquarie (Old) *Continued*							
11	(Macquarie New) 1883.	33° 51′ 2″ S. 151° 18′ 3″ E.	1st order dioptric; holophotal, revolving white light, electric light, gas or oil; visible between N. by E. ¼ E. and S. by E., shewing a flash every minute and making a complete revolution in 16 minutes.	345 ft.	21½	5	£867	£19,63
12	Hornby, 1858	33° 50′ 2″ S. 151° 18′ 7″ E.	1st order catoptric; fixed white	90 ft.	11	3	£513	£5,33

Digitized by Google

AST OF NEW SOUTH WALES.—*Continued.*

DESCRIPTION OF BUILDINGS.

Tower.	Quarters.
dstone, the base of tower externally is 24 square to a height of 16 feet, above which building is circular, the walls being 3¾ feet k at the bottom, tapering to 2¾ feet at the . The tower is entered by a stone staircase n an adjoining lobby, landing on the 1st r above oil store 13½ feet high, from which a ular stone staircase with iron railing rises he next floor 34 feet 8 inches above 1st floor, lantern being reached from this level by ooden ladder. The upper floors and lantern ery are constructed of wood, with iron ing. The lower position of lantern 4½ feet ve floor is also of wood, circular on plan, ered outside with copper. The lantern itself ig duo-decagonal, with vertical and hori- tal framework for glass, surmounted with a per dome and vane.	by domes, 12 feet diameter, framed of wood- work and covered with lead, light being admitted by small glazed lanterns in the apex of each dome. The walls were built of dressed stone- work, designed to work in with base of tower. Two detached rooms, each 13 feet square inside, were also provided, one at each extremity of the ground on the road frontage, for the accommo- dation of the military guard.
iated immediately in the rear of the old ithouse at South Head, of Port Jackson. e tower is 61 feet high from ground to floor antern, divided into 4 stories All floors and rcases are of iron It is circular on plan, feet diameter on the inside, built of sand- ie, dressed both sides, designed to resemble closely as possible the old lighthouse. The e of tower, externally, is 23½ feet square, to eight of 17 feet, above which it is circular, walls being 4 feet thick at the bottom, ering to 3 feet thick at the top. Bluestone ery round lantern, with gun metal railing. gine room, oil stores, and workrooms are vided in 2 one storey wings, one on either of tower and attached to same, the wings ig each about 24 feet square, surmounted by ies constructed of woodwork and covered i lead. The engine room contains two 8-h p. ssley's gas engines, and two De Meritens gneto-eleetric machines, weighing 2½ tons i. A gasholder, containing 4 or 5 days ply, is also provided, connected with the ns of the Australian Gas Light Co.	Quarters are provided for 1 engineer superin- tendant, 1 assistant engineer, and 3 under keepers in 5 one storied houses, in 3 blocks, 1 single house, and 2 blocks of semi-detached. That for the superintendent containing 5 rooms, and all others 4 rooms, and all with kitchens, storerooms, &c. The walls are of dressed stone- work, plastered inside. The roofs covered with galvanized iron, and verandahs round all frontages. Underground rain water tanks, of 6,000 galls. capacity, are provided to each house, and water is laid on from the mains of the Metropolitan Water and Sewerage Board. Stable and cart shed are also provided.
iated on edge of cliff at inner South Head, t Jackson. The tower is 25 feet high from	Quarters are provided for head keeper, con- taining 6 rooms, with kitchen and storerooms,

Digitized by Google

PARTICULARS OF LIGHTHOUSES ON TH

No.	Lighthouse and Date of Construction.	Latitude and Longitude.	Description of Light.	Height of focal plane above high water mark	Visible Horizon in nautical miles.	Keepers.		Cost of Erection.
						No.	Annual Salaries.	
	Hornby— *Continued*		light, shewn from SE by S eastward to NE½ E. Lantern originally imported for King's Island.					
13	Barrenjuey, 1881.	33° 35′ S. 151° 20′ 5″ E.	2nd order dioptric; fixed red light, shewn between SSE and NE through E.	371 ft.	22	3	£431	£16,4
14	Nobby's (Newcastle), 1858.	32° 55′ 3″ S. 151° 49′ 3″ E.	Catoptric; fixed white light, with fixed red light over breakwater.	115 ft.	12¼	3	£513	£4,45

Digitized by Google

AST OF NEW SOUTH WALES.—*Continued.*

DESCRIPTION OF BUILDINGS.

Tower.	Quarters.
und to floor of lantern, painted outside in and white stripes. Circular on plan, 10 feet meter, with walls of 2½ feet thickness at the tom, tapering to 1½ feet thick at the top. ided into 2 floors, the lower floor used as an store, an external flight of stone steps leading to the first floor, the inner staircase, from level to floor of lantern, being of iron. The rs are of wood; the walls are built of sand- ne, dressed both sides. The gallery round tern is of stone, with an iron railing.	and for 2 assistant keepers, each containing 4 rooms with kitchen, laundry, &c. The walls are of dressed, coursed, rubble stone, plastered inside. The roofs covered with galvanized corrugated iron. Verandahs are put to all principal fronts. One underground rain-water tank was provided, holding about 6000 gallons, also several 400 gallon iron tanks for the general use, but the water from the city mains has since been laid on.
nated on Barrenjuey Head, Broken Bay. e tower is 39 feet high from the ground to lantern floor. Circular on plan, 10 feet meter inside. The base externally is agonal to a height of 13 feet, above which the er is circular. It is divided into 3 stories, h iron floors and staircases. The walls are lt of local sandstone, dressed on both sides, eet thick at the bottom, tapering to 2 feet k at the top. The gallery round lantern is of sandstone, supported on massive stone tilevers, and having a gun-metal railing. e oil room is 13 feet square, attached to the e of tower, both it and the tower being ered from a passage leading down by an n stairway to the head keeper's quarters.	Quarters are provided for the head keeper in a detached house containing 5 rooms with kitchen in the basement, and storerooms, the quick slope of the ground making the building 2 stories high on one side; also for 2 assistant keepers in 2 semi-detached cottages, each containing 3 rooms, with kitchen, storerooms, etc. The walls are of dressed, coursed, rubble stonework, plastered inside. The roofs are covered with galvanised corrugated iron. Verandahs are put round all the principal fronts. Underground rain-water tanks of 6,750 gallons capacity are provided to each house.
uated on south side of entrance to Port nter. The tower is 13 feet high from ground loor of lantern. Circular on plan, 10¾ feet meter inside, in one storey, which is used as oil store, etc., a step ladder of wood giving ess to the lantern above The walls are lt of dressed stone 2 feet thick at the base, ering off to 1 foot 5 inches thick at the top. e gallery round lantern is of wood, supported iron cantilevers. The floor of oil store and tern are also of wood. The stone walls are ried up 3 feet 9 inches above the lantern floor, l upon this is set the iron framework, having tical and horizontal bars for glass. The nwork framing is duo-decagonal on plan, l surmounted with a pointed roof, framed of n, and covered with copper.	Quarters are provided for the head keeper in a detached cottage containing 5 rooms and kitchen, and for 2 assistant keepers in 2 semi-detached cottages, each containing 2 rooms and kitchen. The walls are of brickwork on stone foundations, plastered inside. The roofs are covered with galvanized corrugated iron. Verandahs are put to the principal fronts.

Digitized by Google

PARTICULARS OF LIGHTHOUSES ON TH

No.	Lighthouse and Date of Construction.	Latitude and Longitude.	Description of Light.	Height of focal plane above high water mark	Visible Horizon in nautical miles.	Keepers.		Cost of Erection.
						No.	Annual Salaries.	
15	Point Stephens, 1862.	32° 45′ 2″ S. 152° 13′ 3″ E.	3rd class catoptric; revolving red and white light, alternating every minute, with a short eclipse between the colours.	126 ft.	12½	3	£410	£7,400
16	Nelson's Head (Port Stephens), 1872.		Catoptric; fixed white and red light, bright seaward, eclipsed over entrance shoal, red after shoal is passed, and bright to S.W.	175 ft.	15½	1	£134	£2,837
17	Sugarloaf Point (Seal Rocks), 1875.	32° 26′ 3″ S. 152° 33′ 7″ E.	1st order dioptric; holophotal, 16 sided, revolving bright light, flashing every ½ minute, and having a 4th order dioptric fixed green light lower in tower as warning from Seal Rocks. Cost of above in London, £3400; ditto of green light, £80.	258 ft.	18	3	£522	£18,973

Digitized by Google

ıST OF NEW SOUTH WALES.—*Continued.*

DESCRIPTION OF BUILDINGS.

Tower.	Quarters.
ıated on south side of entrance to Port).hens. The tower is 52 feet high from ınd to floor of lantern. Circular on plan, eet diameter inside, divided into 4 stories. floors and interval stairs are of iron. The er floor is utilized as an oil store, the tower lf being entered by a flight of stone steps, ling at 1st floor level. The walls are built sandstone imported from Sydney, dressed ı sides. They are 6 feet thick at the ground , diminishing by a concave batter to 2 feet k at the top. The gallery round the lantern f stone, guarded by an iron railing. The ls are carried up 4½ feet above the lantern r, and upon this is set the metal framework glass.	Quarters are provided for the head keeper and assistant keepers, in a terrace of 3 one storied cottages, the head keeper having 4 rooms, and the others 3 rooms each, all with kitchens, storerooms, &c. The walls are built of dressed Sydney stone, plastered inside. The roofs are covered with slates. A wide verandah is put all round the terrace. Two underground rain-water tanks, each of 7,650 galls. capacity, are provided, also a stable, and a boatshed with slip.
tower is an octagonal structure, 11 feet rnal diameter, 1 storey in height, attached he keeper's residence, and entered from the ındah of same. The walls are built of brick ement, 14 inches thick, cemented outside and The room is vaulted with coke concrete ches thick, over which is the pointed timber framing, covered with galvanized iron, and ı the copper ventilating cowl for lamps in centre. Present structure erected 1876, inally of wood.	Quarters are provided for 1 keeper in a one-storied cottage, containing 4 rooms, with kitchen, and with verandah on 3 sides. The walls are built of brickwork, cemented outside and plastered inside. The roof is covered with galvanized corrugated iron. An underground rain-water tank, of 6,000 galls. capacity, is provided. Erected in 1875.
ıated on Sugarloaf Point. The tower is feet high from ground to floor of lantern n. Circular on plan, 11 feet diameter inside, ded into 2 storeys. The lower floor is used ın oil store. A flight of external bluestone ɔs with gun-metal railing leads from the ınd to the first floor level, at which point the ıt tower is entered, a flight of iron stairs ling up to the lantern. The floor of the ern room is of iron. The 1st floor over oil e is of concrete, it and the oil store being ed with asphalt. The walls are built of dstone, imported from Sydney, dressed both es. They are 2 feet 9 inches thick at the base, ering to 2 feet at the top. The outer gallery nd lantern is of bluestone, with gun-metal ing. A ring fence wall of stone, 4 feet high, h gate, is placed round the tower, leaving a	Quarters are provided for the head keeper in a detached cottage, containing 5 rooms with kitchen, storerooms, &c ; and for 2 assistant keepers in 2 semi-detached cottages, each containing 3 rooms, with kitchen, storerooms, &c. The walls are of sandstone, imported from Sydney, dressed on the outside and plastered inside, on local stone rubble foundations. The roofs are covered with galvanized iron. Wide verandahs are put all round the houses. Underground rain-water tanks are provided to each house, that for the head keeper containing 6,750 galls., and the others 4,725 galls. each. The sites for quarters have been excavated out of the hillside, heavy retaining walls being erected at the back and sides of excavations, and to the pathway to lighthouse.

Digitized by Google

PARTICULARS OF LIGHTHOUSES ON THE

No	Lighthouse and Date of Construction.	Latitude and Longitude.	Description of Light.	Height of focal plane above high water mark	Visible Horizon in nautical miles.	Keepers.		Cost of Erection.
						No.	Annual Salaries.	
	Sugarloaf Point —*Continued*							
18	Crowdy Head, 1879.	31° 51′ 2″ S. 152° 46′ E.	4th order catadioptric; fixed bright light, shewing Red over Mermaid Reef, northward to the land. 270° and 90° reflector.	185 ft.	16	1	£116	£4,365. exclusive of lantern.
19	Tacking Point, 1879	31° 28′ 7″ S. 152° 57′ 3″ E.	4th order catadioptric; fixed bright light. 270° and 90° reflector.	195 ft.	16	1	£126	£4,000. exclusive of lantern.
20	Smoky Cape, 1891.	30° 55′ 7″ S. 153° 6′ E.	1st order dioptric; bright light, shews 3 flashes in 10 seconds, followed by 20 seconds eclipse. A subsidiary red light is provided on the first floor of tower, to cover the Fish Rock danger, with 1 mile clear in all directions.	420 ft.	23	3	£427	£12,400

Digitized by Google

ÅST OF NEW SOUTH WALES.—*Continued.*

DESCRIPTION OF BUILDINGS.	
Tower.	**Quarters.**
r space of 9 feet all round, paved with glazed ing bricks.	
ıated on Crowdy Head, Manning River. tower is 12 feet high from the ground to r of lantern room. Circular on plan, 6 feet ıeter inside, in 1 storey, with an internal staircase. The walls are built of brickwork ıot 7 inches thick at the base, tapering to ıot 2 inches thick at the top. The outer ery round lantern is of bluestone, supported ıluestone corbels, and with an iron railing. floor of lantern room is of iron. The tower ıds on a bed of concrete, 2 feet 6 inches k, forming floor and foundations. Annexed he tower is an enclosed porch, and 2 rooms, ing an oil store, and the other a room for keeper when on duty; all built of brick, ed with galvanized iron, the rooms having rded floors, and the porch a concrete floor. walls are cemented outside and plastered de.	Quarters are provided for 1 keeper in a detached cottage, containing 4 rooms, with kitchen and store, &c., and with back and front verandahs. The walls are built of brickwork, on local rubble stone foundations, the walls being cemented outside and plastered inside. The roof is covered with galvanized iron. An underground rain-water tank, of 6,000 galls. capacity, is provided.
ıated on Tacking Point, Port Macquarie. ıstruction precisely similar to that at Crowdy ıd.	Precisely similar quarters to those provided at Crowdy Head.
ıated on Smoky Cape, Trial Bay. The tower 2 feet high from ground to floor of lantern n, 12 feet diameter inside, and octagonal ıide, divided into 2 stories, with iron floors staircases. The walls are built of mass crete, cemented inside and out, 3½ feet thick he base, tapering to 2½ feet thick at the top. gallery round lantern is of granite, sup- ted on moulded granite cantilevers, and ing a gun-metal railing. The tower ıred from an enclosed passage 4½ feet wide, n which also 2 storerooms are entered, each feet x 10 feet. The walls of which are also t of mass concrete. A screen wall of crete, 4 feet high, is built all round the er, at a distance of 7½ feet from same, the e thus enclosed, also the floors of store- ns, being paved with concrete, and cemented.	Quarters are provided for the head keeper in a detached cottage, containing 4 rooms, with kitchen and stores, also a room for visiting officers; and quarters for 2 assistant keepers 2 semi-detached cottages, each containing 4 rooms, with kitchen and stores. The walls are built of mass concrete, cemented outside and plastered inside. The roofs are covered with galvanized iron. Verandahs, 8 feet wide, are put all round the buildings, roofed with galvanized iron, and paved with concrete. Cemented underground rain-water tanks, of 6,000 galls. capacity, are provided to each house. A stall stable, with cart shed and forage room, are also provided. Extensive excavation and stone retaining walls were necessary in preparing the sites for these buildings.

Digitized by Google

PARTICULARS OF LIGHTHOUSES ON TH

No.	Lighthouse and Date of Construction.	Latitude and Longitude.	Description of Light.	Height of focal plane above high water mark	Visible Horizon in nautical miles.	Keepers.		Cost of Erection.
						No.	Annual Salaries.	
	Smoky Cape—*Continued*							
21	South Solitary Island, 1880.	30° 11′ 8″ S. 153° 17′ 3″ E.	1st order holophotal, 8 sided dioptric; revolving bright light, with eclipses every ½ minute.	192 ft.	16	3	£373	£31,259
22	Clarence Heads, 1866.	29° 25′ 5″ S. 153° 23′ 2″ E.	4th order catadioptric, fixed bright light. 270° and 90° reflector.	35 ft.	6¾	Pilot	£106	£1,097
23	Richmond Heads, 1866.	28° 51′ 5″ S. 153° 35′ 9″ E.	4th order catadioptric, fixed bright light. 270° and 90° reflector.	116 ft.	12¼	1	£106	£4,112
24	Fingal Head, 1872.	28° 11′ 2″ S. 153° 35′ 5″ E.	4th order catadioptric, fixed bright light, obscured by Cook Island between N. E. ¼ E. and E.N.E.; 270° and 90° reflector.	80 ft.	16¼	1	£106	£4,357

Digitized by Google

AST OF NEW SOUTH WALES.—*Continued.*

DESCRIPTION OF BUILDINGS.

Tower.	Quarters.
e roofs of storerooms are covered with vanized iron.	
uated on the summit of the island. The ver is 40 feet high from ground to floor of tern room. Circular on plan, 11 feet meter inside, divided into 3 stories, with 1 floors and staircases. The walls are built mass concrete, 4½ feet thick at the base, ering to 2½ feet thick at the top, cemented ide and out. The gallery round lantern is of estone, supported on a massive oversailing ulded concrete cornice, and furnished with a 1-metal railing. The tower is entered from enclosed passage 5½ feet wide, with 2 store ms opening from same, one being 20 ft x 13 ft., l the other 10 ft. by 5 ft., the walls of which also built of mass concrete, the roof being ered with galvanized iron. A screen wall of crete, 4 feet high, surrounds the tower at a tance of 9 feet from same, the space thus losed, also the floors of storerooms, &c., are ed with concrete.	Quarters are provided for the head keeper in a detached cottage containing 4 rooms, with kitchen and stores, also a room for visiting officers; and quarters for 2 assistant keepers in 2 semi-detached cottages, each containing 3 rooms, with kitchen and stores. The walls are built of mass concrete, cemented outside and plastered inside. The roofs are covered with galvanized iron. Verandahs 7 feet wide are put all round the buildings, roofed with galvanized iron, and paved with concrete cemented. Underground rain-water tanks of 6,000 gallons capacity are provided to each house. A skeleton wharf, with tramway, travelling crane, and storeroom, are provided at the landing place.
uated on South Head, Clarence River. nstruction and design precisely similar to t at Crowdy Head.	No special quarters provided.
uated on North Head, Richmond River. nstruction and design precisely similar to t at Crowdy Head.	Quarters are provided for 1 keeper. Precisely similar in design and construction to that at Crowdy Head.
uated on Fingal Head, Tweed River. Con-uction and design precisely similar to that Crowdy Head.	Quarters are provided for 1 keeper. Precisely similar in design and construction to that at Crowdy Head.

NOTE.—Nos. 1, 3, 4, 11, 13, 16, 17, 18, 19, 21, 22, 23 and 24, were constructed by Mr. Barnet, Colonial Archi-t. Nos. 2, 5, 12, 14 and 15, were constructed by Mr. Dawson, Colonial Architect. No. 8 was constructed by Mr. riarty, Engineer in Chief for Harbours and Rivers. No. 10 was constructed by prison labour, under direction of otain J. Gill, Engineer, and F. H. Greenaway, Civil Architect. No. 20 was commenced by Mr. Barnet, Colonial chitect, and completed by Mr. Darley, Engineer in Chief for Public Works. No. 6 is being constructed by Mr. rley, Engineer in Chief for Public Works.

Digitized by Google

STATEMENT SHOWING WHERE WRECKS OCCURRED NORTH COAST.

Lighthouses Erected.		Year.	Tweed River.	Brunswick.	Byron Bay.	Richmond River	Evans Reef.	Clarence River.	Sandon Bluff.	Woolgoolga.	Coff's Harbor.	Bellinger River.	Nambucca River	Macleay River.	Trial Bay.	Port Macquarie.	Tacking Point.	Camden Haven.	Manning River.	Cape Hawke.	Charlotte Bay.	Seal Rocks.	Port Stephens.	Newcastle.	Lake Macquarie.	Hunters Nurah Thurrah.
Year.	Place.																									
		1807	...	...	...	..	...	...	...	...	...	.	..	..	..	..	..	...	...	..	.	...	1	.	..	..
		1808	...	.	...	...	...	...	...	...	.	.	...	...	...	...	...	...	...	..	..	...	.	1	...	..
1813	Outer S'th H'd, Syd.	1813	...	...	...	...	...	.	...	...	..	..	..	..	..	...	...	...	...	..	..	...	..	.	...	...
		1814	...	...	..	...	...	...	...	...	..	..	..	..	...	...	...	...	...	..	..	...	..	.	...	...
		1828	.	..	..	...	...	...	...	...	...	..	..	..	...	...	...	...	...	...	..	...	1	.	...	..
		1829	..	...	...	...	...	...	...	...	...		..	..	...	.	...	...	...	...	..	...	..	.	...	...
		1833	...	..	..	...	...	...	...	...	...		..	..	...	...	...	...	...	...	..	...	..	.	...	...
		1834	..	.	...	...	...	...	...	...	...		..	..	...	.	...	...	...	...	..	...	..	.	...	...
		1835	...	...	...	...	...	...	...	...	...		..	..	...	...	...	...	...	...	..	...	.	.	...	...
		1836	...	...	...	.	...	.	...	...	...		..	..	...	...	...	...	...	...	..	...	..	.	...	1
		1839	.	...	...	...	...	...	...	...	...		.	..	.	...	...	...	...	...	..	.	..	1	...	...
1858	Inner S'th H'd, Syd.	1854	...	...	...	1	.	...	..	...	...		.	..	1	...	...	...	...	...	..	.	..	.	...	...
1858	Nobbys, Newcastle	1857		..	...	...	...	..	..	...	...		..	.	..	...	...	...	...	...	..	...	..	.	...	.
1860	Cape St. George, Jervis Bay	1862	...	...	.	...	...	...	..	.	...		...	...	...	...	.	..	.	...	..	...	..	.	...	..
1862	Port Stephens ..	1863	.	...	...	...	...	...	...	..	..		.	...	...	.	...	...	...	...	.	1	.	.	...	.
		1864	...	..	...	...	.	1	...	...	...		.	...	...		...	...	...	...	1	2	1	.	...	..
		1866	..	.	...	...	.	1	...	...	...		1	...		1	...	1	...	...	..	1	3	.	...	...
		1867	..	...	.	.	...	...	...	...	...		...	...	...	...	1	.	...	...	..	...	...	.	...	..
		1868	..	..	...	.	..	...	...	...	...		.	.	..	...	...	3	1	.	1	1	1	...	...	2
		1869	...	.	...	..	...	.	...	...	..		.	...	...	...	...	...	...	.	..	...	..	.	...	..
		1870	1	.	...	.	...	...	...	...	...		...	...	...	...	...	..	.	...	1	.	1	.	...	.
		1871	.	...	...	1	...	...	...	.	.		...	...	...	...	...	...	...	...	..	...	..	.	...	...
1872	Pier h'd, Wollongong	1872	..	...	...	1		1	..	...	...		...	...	...	...	...	.	...	...	..	...	..	.	...	...
1873	Pier, Ulladalla, since removed to Warden Head	1873	1	...	..	2	..	1	...	...	...	...	..	1	1	...	...	...	1	1	..	..	.	...	1	
		1874	...	1	...	2	1	1	.	..	..	1	1	...	...	...	...	...	1	1	..	1	1	4	..	..
		1875	..	1	...	1	...	1	..	...	..	...	...	...	1	...	...	...	2	...	..	...	2	.	2	..
1876	Sugarloaf Pt, (Seal Rocks)	1876	...	..	1	1	...	1	...	...	...	..	...	.	...	...	...	4	.	2	...	1	3	.	.	..
1876	Nelson Head (Port Stephens)	1877	2	.	...	2	.	...	...	...	..	1	1	.	...	..	1	1	...	1	1	5	...	.		
		1878	1	1	...	.	...	2	...	...	...	3	1	1	.	...	1	1	...	.	...	.	2	...	.	
1879	Fingal Head (near Tweed River) ..	1879		2	1	1	...	1	..	...	...	.		1	...	2	...	.	1	1	...	1		3	...	2
1879	Richmond River ...	1880	.	1	..	2	..	1	..	...	...	1	.	.	...	...	...	1	...	1	...	...	.	1	...	..
1879	Clarence River ...	1881	1	..	.	1	...	...	..	.	.	...	1	.	.	...	...	1	...	1	...	...	.	...	.	
1879	Tacking Point ..	1882	.		..			1	.	..	..			1	.	...	1	.	1	.	...	...	1		...	1
1879	Crowdy Head	1883	..	.	..	3			.	...	...		...	...	...	...	...	...	...	...	...	...	1	.		
1880	South Solitary Island	1884	1	1	...		...	...	.	...	..	3	...	1	...	1	...	...	.	...	.	1	1	1	.	..
1880	Baranjuey (Broken Bay)	1885	.	.	...	1	1	.	...	...	...	...	.	...	...	.	3		...	.	..	...	4	.	...	
1880	Montagu Island ...	1886	.	.	1		..	1	..	...	...	...	...	.	.	1	1	...	2	1	...	..	3	.	...	1
1880	Twofold Bay .. .	1887	1	2	..	1	.	1	...	...	...	...	...	...	1	...	...	...	...	...	...	...		.	...	1
1882	Shoalhaven River ...	1888	1	.	.	.	...	...	...	...	...	...	...	...	...	...	...	...	1	1	...	.	.	1	.	1
1883	Green Cape	1889	..	.	4	..	1	1	1	..	.	...	...	..	...	...	...	2	...	...	..			.	.	
1886	Kiama	1890		1	...	1	...	...	...	...	...	...	...	.	...	...	...	.	.	..	..	...	1	..	.	
1889	Warden Head, Ulladulla	1891	.	1	1	..	.	...	...	.	2	1	...	...	...	1	..	...	...	..	..	1	2	...	..	
1891	Smoky Cape (near Trial Bay)	1892	...	1	...	2	.	...	...	..		...	1	..	.	...	...	...	...	..	..	.	.	.	.	1
		1893	..	1	1	..	...	.	...	1	2	...	...	...	..	..	.	1	...	...	...	...	1	1	1	..
		1894	.		1	1	...	...	..	.	...	...	.	...	...	...	...	...	1	..	...	2	2	.	1	
		1895	...	.		.	.	.	1	.	...		.	1	1	...	...	...	...	...	1	...	1	.	.	
		1896	1	...	.	..	...	1	...	...		2		.	...	...	.	1	...	.	..	.	2	...	...	.
	Totals ...		10	13	10	24	3	16	1	2	4	8	8	5	6	7	5	11	17	11	1	9	34	27	3	12

Digitized by Google

SOUTH COAST.

Broken Bay.	Long Reef.	SYDNEY.	Botany.	Port Hacking.	Bulli.	Bellambi.	Wollongong.	Shellharbor.	Kiama.	Gerringong.	Shoalhaven.	Wreck Bay.	Ulladulla.	South Coast.	Tomakin.	Moruya River.	Wagonga.	Rock near Montagu Island.	Merimbula.	Twofold Bay.	Green Cape.	Foundered.	Year.	Lighthouses Erected. Place.	Year.
..	..	1	..	..	..	..	..	..	..	.	.	..	..	..	..	..	..	..	..	..	..	..	1807		
..	..	..	..	..	..	..	..	..	..	.	.	..	..	..	..	..	..	..	..	..	..	..	1808		
..	..	..	..	..	..	..	..	..	..	.	2	..	..	..	..	..	..	..	..	..	..	..	1813	Outer S'th H'd, Syd.	1813
..	.	1	.	.	.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.	..	..	1814		
..	.	..	.	..	..	..	..	..	..	.	..	..	..	..	..	..	..	..	..	.	..	..	1828		
..	..	1	..	..	..	..	..	..	..	.	.	..	..	..	..	..	..	..	..	..	..	.	1829		
..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1833		
..	..	1	.	..	..	..	..	..	.	..	..	1	..	.	.	..	..	..	..	.	.	..	1834		
..	..	..	..	..	..	..	..	..	..	..	.	..	..	..	..	..	..	..	..	..	..	..	1835		
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1836		
..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.	1839		
..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1854	Inner S'th H'd, Syd.	1858
..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.	1857	Nobbys, Newcastle	1858
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	1862	Cape St. George, Jervis Bay	1860
..	.	.	.	.	.	1	.	.	..	..	..	1	..	..	..	..	..	..	1	..	..	..	1863	Port Stephens... ...	1862
..	..	1	..	.	1	..	1	.	..	..	..	..	..	..	..	..	..	..	..	1	..	..	1864		
..	..	..	..	1	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1866		
2	..	..	..	..	1	..	..	..	..	..	1	.	..	..	..	..	..	..	..	..	..	..	1867		
..	..	1	..	..	..	.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1868		
..	..	1	..	..	..	..	..	..	1	..	..	2	1	.	..	..	..	..	..	..	..	..	1869		
..	..	..	.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1870		
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1871		
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1872	Pier-h'd, Wollongong	1872
1	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	8	1873	Pier, Ulladulla, since removed to Warden Head	1873
..	..	1	1	1	..	..	..	.	..	..	..	2	..	..	..	..	..	..	1	.	..	3	1874		
..	1	..	1	.	..	..	..	..	..	..	..	.	..	..	..	..	..	.	.	.	..	..	1875		
2	..	1	..	..	.	..	..	..	.	.	..	..	..	..	..	..	1	..	..	..	..	9	1876	Sugarloaf Pt. (Seal Rocks)	1876
..	..	..	..	1	.	..	..	..	.	..	..	..	..	..	..	..	..	..	..	..	..	6	1877	Nelson Head (Port Stephens	1876
2	..	.	..	..	..	..	..	.	1	..	..	..	..	..	..	..	..	..	..	.	..	7	1878		
..	..	..	..	2	..	..	..	2	.	1	..	..	..	3	.	.	..	..	..	..	..	4	1879	Fingal Head (near Tweed River	1879
..	1	1	..	..	..	..	..	1	..	..	1	..	..	..	..	..	..	1	..	..	..	..	1880	Richmond River ..	1879
..	1	2	..	..	..	..	..	..	..	..	.	1	..	..	..	..	..	..	..	.	..	6	1881	Clarence River ...	1879
..	..	..	2	.	..	1	..	..	..	..	1	..	1	..	..	1	..	..	..	..	..	..	1882	Tacking Point ...	1879
..	..	1	1	..	..	..	..	..	..	..	..	..	..	..	1	..	1	..	..	..	..	1	1883	Crowdy Head	1879
..	..	1	1	.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	7	1884	South Solitary Island	1880
..	.	..	..	..	..	1	.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.	1885	Barranjuey (Broken Bay)	1880
..	..	1	..	1	..	..	..	..	..	..	..	1	.	..	..	..	..	..	..	..	1	..	1886	Montagu Island ..	1880
..	..	2	..	..	..	1	..	..	..	.	.	..	..	..	..	..	..	..	..	..	..	.	1887	Twofold Bay	1880
1	.	1	..	..	..	..	..	..	..	1	..	..	..	..	1	..	1	..	..	..	..	5	1888	Shoalhaven River ...	1882
1	.	1	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	6	1889	Green Cape	1883
..	1	.	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	9	1890	Kiama	1886
1	..	..	..	..	..	.	..	..	.	.	..	..	1	..	..	1	..	..	.	.	..	6	1891	Warden Head, Ulladulla	1889
..	.	..	..	.	..	.	.	.	.	..	..	..	.	..	..	..	..	..	.	..	..	6	1892	Smoky Cape (near Trial Bay)	1891
..	..	..	..	1	..	..	..	..	..	..	1	..	1	..	..	1	..	..	..	..	..	2	1893		
..	..	..	..	.	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	9	1894		
..	..	2	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3	1895		
..	.	..	.	..	..	.	.	.	..	.	..	..	..	..	..	..	..	..	..	..	..	2	1896		
10	3	28	6	7	3	5	1	3	4	2	6	8	4	3	3	4	3	1	2	1	2	99			

Digitized by Google

STATEMENT OF WRECKS OFF THE COAST OF NEW SOUTH WALES, SHOWING HOW CAUSED, FROM 1873 TO 1896, INCLUSIVE.

Year.	Lost on bar or spit, through wind failing, or thro' gales, squalls, or freshes.	Beached.	Washed out of River By Floods.	Accident to Steering Gear or other Machinery.	Foundered through leaking, etc.	Driven or Drifted Ashore.	Collision.	Striking Bar or Shore at Entrance.	Missed Stays.	Ran Ashore or On Rocks.	Attempts to cross Bar at Night.	Capsized.	Fire.	Remarks.
1873	4	...	*1	2	8	2	...	...	2	...	1	...	..	*S.S. *Coolangatta* washed out of Shoalhaven River, capsized, and foundered.
1874	7	...	...	1	4	7		...	1	*1	...	2	...	**Rose of Australia* ran into Wreck Bay during S.W. gale and thick weather. Cape St. George light could not be seen.
1875	5	...	...	...	3	4	...	1	1	*1	..	...	...	*Ketch *Pioneer* on South Head, Botany Bay, in fog
1876	5	1	...	..	9	8	...	1	1	1	...	...	...	
1877	6	...	...	1	5	3	1	2	1	*2	...	1	...	*S S. *Florence Irving* struck rock near Port Stephens during fog.
1878	4	...	..	1	6	2	1	5	1	1	...	1	...	
1879	1	...	...	1	4	9	1	6	2	*4	...	..	..	I.S.N. S.S. *John Penn*, near Murrawarra Head in thick fog, and navigating too close. Two others ran ashore during fog.
1880	2	1	...	1	6	1	...	3	...	1	1	2	...	
1881	2	...	...	2	7	1	1	1	1	*2	...	...	..	**Collaroy* and barque *Queen of Nations* during fog.
1882	...	.	...	2	2	...	3	1	2	*6	...	†2	...	*S.S. *Fiona* mistook Port Stephens light for Seal Rocks light. †S.S. *Austral* while coaling in Port Jackson. Three vessels raised.

Digitized by Google

STATEMENT OF WRECKS OFF THE COAST OF NEW SOUTH WALES.—*Continued.*

Year.	Lost on bar or spit, through wind falling, or thro' gales, squalls, or freshes.	Beached.	Washed out of River By Floods.	Accident to Steering Gear or other Machinery.	Foundered through leaking, etc.	Driven or Drifted Ashore.	Collision.	Striking Bar or Shore at Entrance.	Missed Stays.	Ran Ashore or On Rocks.	Attempts to cross Bar at Night.	Capsized.	Fire.	Remarks.
1883	1	...	...	1	1	1	...	5	...	*1	...	...	...	*Mistook light on Bondi Beach for Macquarie light.
1884	2	...	...	1	6	6	...	2	2	...	...	...	...	
1885	2	...	...	...	1	3	...	2	1	*2	...	...	...	*S.S. *Cahors* ran into Evans' Reef.
1886	2	2	...	1	3	2	3	1	3	*5	...	1	...	S.S. *Corangamite* ran into Wreck Bay during fog.
1887	...	...	...	...	3	6	...	2	2	...	...	..	..	S.S. *Ly-ee-Moon*, S.S. *Malua*, and *Fifeshire* also wrecked in fog (on fine night).
1888	...	...	...	...	5	3	3	2	1	*1	...	...	...	
1889	...	2	...	...	6	6	1	1	..	*4	...	...	..	Barque *Speedwell* ran into Bungaree Norah Beach in fog. S.S. *Duckenfield* on Long Reef in fog. Also, schooner *Heath*, entrance Broken Bay in fog.
1890	...	..	*1	...	7	3	2	1	...	†2	...	...	...	*Dredge *Clarence*. † One during fog, and one in fine weather, on Sutherland Reef.
1891	2	1	..	1	6	3	...	3	1	...	...	...	1	
1892	...	...	...	...	6	1	...	4	...	...	...	..	...	
1893	...	1	..	1	2	5	1	2	1	1	...	1	...	
1894	1	1	...	..	8	2	1	2	1	*2	..	..	...	*Ketch *Dolly Walmsley* on Stony Point, Newcastle, in fog.
1895	...	...	..	...	3	3	1	2	...	2	...	...	...	
1896	2	1	...	1	1	1	..	2	...	1	..	..	...	
	48	10	2	17	112	82	20	51	24	40	2	10	1	Total... 419

Digitized by Google

STATEMENT OF WRECKS OFF THE COAST OF NEW SOUTH WALES, FROM THE YEAR 1873 TO 1896 INCLUSIVE.

Year.	No. of Wrecks.			Tonnage.	No. of Crew and Passengers.	Lives Lost.	Estimated Value.	Insurance.	No. Insured.	Remarks.
	Steam.	Sail.	Total.							
							£	£		
1873	4	16	20	2,659	158	35	30,620	4,200	7	
1874	..	24	24	2,769	155	21	40,010	4,550	7	
1875	2	13	15	1,715	122	28	25,200	13,550	8	
1876	..	26	26	1,970	121	39	21,890	13,606	17	
1877	2	20	22	3,213	171	8	67,783	19,130	8	One insurance value not given.
1878	1	21	22	2,031	198	Nil	49,752	17,659	20	
1879	5	23	28	3,458	303	16	84,018	47,900	26	
1880	4	14	18	3,816	194	47	*20,910	..	Nil	* Two values not given.
1881	2	15	17	3,731	203	39	No values given.	..		
1882	10	8	18	6,782	482	37	*103,150	*148,800	12	* O.S.N. *Austral*, value not given, said to be insured for over £100,000 (subsequently raised).
1883	3	7	10	753	50	Nil	18,800	4,500	5	
1884	5	14	19	3,325	146	20	31,820	4,450	5	
1885	2	9	11	1,610	246	7	69,800	12,900	7	
1886	11	12	23	5,401	547	111	*122,730	43,300	12	* Two values not given; S.S. *Helen Nicoll* collided with *Keilawarra*, but did not sink.
1887	3	10	13	2,009	89	2	36,450	..	Nil	
1888	6	9	15	2,573	122	8	47,360	800	...	
1889	4	16	20	2,420	192	4	50,040	..	Nil	
1890	6	10	16	5,303	185	31	*145,350	..	Nil	Dredge *Clarence* washed out of Clarence River; about £16,000.
1891	2	16	18	2,988	123	47	*28,830	..	Nil	* Two values not given.
1892	4	7	11	783	61	16	*17,485	..	Nil	* One value not given.
1893	4	11	15	1,759	128	4	27,310	..	Nil	
1894	6	12	18	2,758	139	10	45,523	..	Nil	
1895	5	6	11	3,948	137	63	*77,095	..	Nil	* One value not given; S.S. *Catterthun*, value £70,000.
1896	5	4	9	1,043	72	2	18,810	..	Nil	
24	96	323	419	68,817	4,344	595	£1,180,736	£335,845	134	

Digitized by Google

A TESTING MACHINE FOR EQUAL ALTERNATING STRESSES.

By Prof. W. H. Warren, M. Inst. C.E., Wh. Sc.

[*Read before the Engineering Section of the Royal Society of N. S. Wales, December 21, 1898.*]

This machine was designed and constructed in the Engineering School of the University for the purpose of subjecting test specimens to equal alternating stresses, and thus determining the vibrating strength of the material.

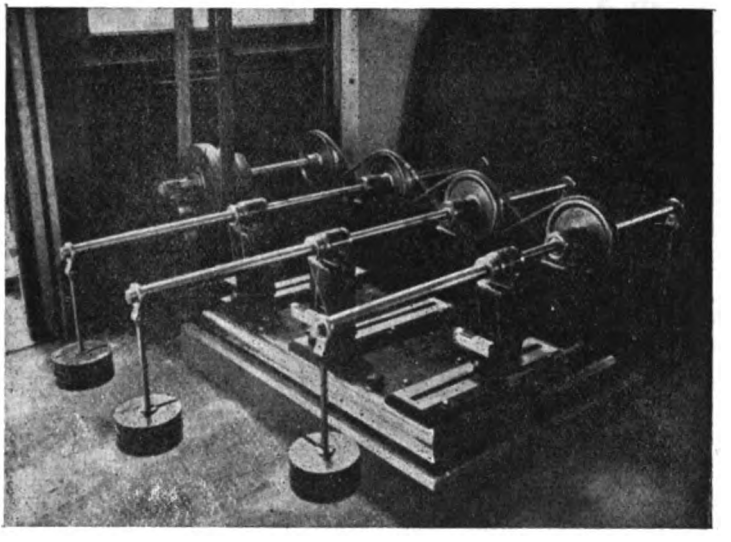


Fig. 1.

As will be seen from the diagram (Fig. 2), three specimens are tested at the same time; and spare test pieces are kept in stock to replace those that are the first to fail, so that all the spindles may be maintained in continuous rotation. The three pedestals on one side of the base plate can be moved transversely, to allow of different lengths of test pieces being used. For example,

Digitized by Google

FIG. 2.

Digitized by Google

it will be observed that in the illustration (Fig. 1) one of the test pieces is considerably shorter than the other two. The extreme lengths between the shoulders of the piece are 18 inches and 3 inches respectively. The specimen to be tested is screwed at each end into the overhanging spindles, and these rotate in bearings supported on knife edges. In this way the bending moment is constant over the span from knife-edge to knife-edge, and the test piece in breaking will therefore select the plane of greatest weakness throughout its length.

The machine will be used in the first place for determining the vibrating strength of materials, and the effect of alternating stress upon the position of the elastic limit.

Digitized by Google

Digitized by Google

INDEX.

A	PAGE
Acetylene light	xxxi.
Acid reagents for blue pigment in corals etc.—Butyric ...	262
—— Caprylic acid	262
—— Citric acid	263
—— Ethylidene lactic acid ...	262
—— Formic acid	262
—— Glycollic acid	262
—— Heptoic acid	262
—— Hydrochloric acid... ...	260
—— Lactic acid	262
—— Nitric acid...	261
—— Nonylic acid	262
—— Oleic acid	262
—— Oxalic acid	263
—— Proprionic acid	262
—— Propionitril	262
—— Sulphuric acid	261
—— Tartaric acid	263
Address to Engineering Section	I.
Adelaide Water Supply ...	II.
Aeronautics	55, x.
Agriculture, Department of ...	23
—— Chemical Laboratory ...	24
—— Dairying	26
—— Entomology	26
—— Pathology	27
—— Vine culture	25
Algæ, brown	xv.
Amansia marchantioides ...	170
Anniversary Address	1
Antarctic research	39
Antedonin	265
Aplysiopurpurin	266
Armstrong, Dr. W. G., on Disinfection of Dwellings in Notifiable Infectious Diseases...	lxv.
Artesian Bores	30, xiv.
—— Water in N.S.W....	88, xi.
Artificial silk ...	xxxi.
Auditors	xli.
Auditory ossicles, model demonstrating action of	xix.
Australian divisional systems	66, x.
—— Museum	33
Australasian Association for the Advancement of Science ...	42

B	PAGE
Baker, R. T., F.L.S., and Smith, H. G., F.C.S., On the "Stringybark" trees of N. S. Wales, especially in regard to their essential oils ...	104, xiii.
Barkunjee tribes ...	241, xli.
Barraclough, S. H., M.M.E., Assoc. M. Inst. C.E., and Warren, Prof. W. H., Wh. Sc., M. Inst. C.E., &c., On some physical properties of nickel steel ...	150, xix.
Bastow, Richard A., Key to tribes and genera of Melanospermeæ (Olive-green seaweeds) ...	169, xv., xxv.
Bernier, Julien, Etude sur les dialectes de la Nouvelle-Calédonie	173, xxv.
Biology	40
Blue coral ...	256, xxxi, xlii.
—— pigment in animal organisms	259
Books purchased in 1898	...lviii.
Botanic Gardens	33
Boultbee, J. W., On artesian water in N.S. Wales	88, xi.
Bridges in N. S. Wales... ...	xi.
"Brown Stringybark"	105, 106
Building and Investment Fund	iv.
Burge, C. O., M. Inst. C.E., The narrow gauge as applied to Branch Railways in New South Wales ...	xxii.

C	
Carleton, H. R., M.A.I., M. Inst. C.E., New South Wales Lighthouses	lxxxii.
Chemistry	31
Circumcision	245
City Railway	13
Clarke Medal, awards ...	(xxiv.)
—— Memorial Fund ...	v.
Conversazione 14 Jan., 1898 ...	11
Copper nuggets, sections of ...	xxi.
Coral, blue pigment in 256, xxxi., xlii.	
—— rock cores, from Funafuti	xxxi.
Current observations on Canadian-Australian route	120, xiv.

Digitized by Google

PAGE

Current papers 230, xxxi.
Cyanide Process in N. S. Wales xiii.

D

Deep water wharf ... lxiv.
Deane, Henry, M.A., M. Inst. C.E., Anniversary Address ... 1
Dialectes de la Nouvelle-Calédonie 173, xxv.
Disinfection of dwellings ... lxv.
Divisions of native tribes, Barkunjee, N. S. Wales 241, x., xli.
—— North Queensland . 250
Donations xi., xvi., xxiii., xxvii., xxxii., xxxviii., xliv.
Doris 266

E

'Edible earth' of Fiji ... xliv.
Electric Tramways ix.
Emu egg shell 268
Engineering Section, Committee vi.
—— meetings in 1897 10
—— proceedings lxi.
—— construction in connection with rainfall ... xxxiii.
Essential oils of the N. S. Wales "Stringybark" trees 104, xiii
Eucalyptene 207
Eucalyptus amygdalina 195
—— *Baileyana*, F.v.M.... ... 104
—— *Bridgesiana* 200
—— *capitellata*, Sm. 104–107, 112, 114, 115
—— *coriacea* 196
—— *dextropinea* ...197, 199, 201, 205
—— *eugenioides*, Sieb 104, 106 –108, 113–115
—— *fastigata*, Deane & Maiden 104
—— *globulus* 198–200
—— *goniocalyx* 200
—— *lævopinea* ... 196–198, 202
—— *macrorhyncha*, F.v.M. 104 –108, 110, 111, 114–117, 198
—— *obliqua*, L'Her. ... 104, 198
—— oil, a new xxvi.
—— *piperita*, Link., 104, 116, 196, 198
—— *punctata*, DC. 105, 107, 108, 111, 117
—— *triantha*, Link 104
Eudesmene 207
Eudesmol 116
Exchanges 11

PAGE

F

Fiaschi, Dr., Notes on two cases of amputation of the Rectum for Extreme Prolapsus ... lxv.
Financial Position .. 11, iii.
Fiji 'edible-earth' xliv.
Formic Aldehyde Gas as a disinfectant lxiv.
Funafuti coral boring expedition 36

G

Galena, artificial xli.
Geological Survey of N.S.W... 28
"Grey gum" 105
Group divisions of the Barkunjee tribes... 241, xli.

H

Harbours and Rivers Branch... 14
Hargrave, L., on Aeronautics 55, x.
—— on Soaring Machines 209, xxxv.
Haycroft, J. I., M. Inst. C. E. I., &c., Engineering construction in connection with rainfall xxxiii.
Hæmocyanin 267
Heliopora cærulea 256, xxxi., xlii.
Hepworth, Capt. M. W. Campbell, F. R. Met. Soc., F.R.A.S. R.M.S. "*Aorangi*," on Current observations on the Canadian-Australian route 120, xiv.
High Carbon Rails 14
Hormosira Banksia 170
Houghton, T. H., M. Inst. C.E. Annual Address to the Engineering Section i.

I

Ianthina 266
Imperial Institute, London ... ix.
Indigo 267
Infectious diseases and disinfection of dwellings lxv.
Initiation ceremonies of the Barkunjee tribes ... 241
Intercolonial Engineering works ii.
Interdental splint lxv.
International Scientific Catalogue xvii.

K

Kuranda ceremony, the ... 243

L

Larmer, Mr. Surveyor, Native vocabulary of miscellaneous N. S. Wales objects 223, xxxv.

Digitized by Google

PAGE

Leucocytes lxv.
Library 11
Lighthouses, N. S. Wales LXXXII.
Liversidge, Professor, M.A., LL.D., F.R.S., on The blue pigment in coral *(Heliopora cærulea)* and other animal organisms 256, xxxi., xlii.
—— Native silver accompanying matte and artificial galena xli.

M

Macleay Bacteriologist ... 41
Maori net sinkers xx.
Mathews, R. H., L.S., on Australian Divisional Systems 66, x.
—— on The group divisions and initiation ceremonies of the Barkunjee tribes ... 241, xli.
Medal, awards of the Clarke (xxiv.)
—— Society's, and money prize (xxiv.)
Medical Section, Committee ... ix.
—— meetings in 1897 10
—— proceedings lxiv.
Melanospermeæ 169, xxv.
Melbourne Sewerage Works III.
Members, Corresponding (xxiii.)
—— Honorary (xxiii.)
—— Obituary 1898 ... (xxiii.)
—— Ordinary(xi:)
Mining notes for 1897 27
Monier system of combined concrete and steel construction 16
Myriodesma quercifolia ... 170, 172

N

Narrow gauge as applied to Branch Railways in N.S.W. XXII.
Native names of runs in the Lachlan District xxi.
—— silver accompanying matte and artificial galena ... xli.
Native vocabulary ... 223, xxxv.
Net sinkers of barytes... ... xx.
New Colony Map ... 37
—— Hebrides, communication with 41
—— South Wales Lighthouses LXXXII.
Nickel steel 150, xix
Nouvelle-Calédonie, dialectes de la 173, xxv.

O

Obituary 1897 5
Obituary 1898 (xxiii.)
Observatory Sydney 38
—— Mount Kosciusko... ... 38
Ocean currents ... 236 - 240, xxxi.
Oils (essential) of the "Stringybark" trees... ... 104, xiii.
—— of the genus Eucalyptus 195
Original Researches 11

P

Papers read in 1887 8
Periodicals purchased in 1898 lvii.
Phormosoma hoplocantha ... 35
Physical properties of nickel steel 150, xix.
Physikalisch Gesellschaft Königsberg i. Pr. Prize xviii.
Pinenes of the oils of the genus Eucalyptus 195, xxix.
Proceedings of the Engineering Section lxi.
—— Medical Section lxiv.
—— Society iii.
Purification of Sewerage ... 16
Purple pentacrinin 265
Purpura capillus... 266
Pyocyanin 267

R

Railway Commissioner's Dept. 12
—— Narrow Gauge ... XXII.
Rainfall in connection with Engineering construction XXXIII.
Reception July 14th, 1897 ... 10
"Red Stringybark" 105
Road Bridges 15
Rules alterations to ... vi., vii., x.
Russell, H. C., B.A., C.M.G., F.R.S., Current Papers, No. 3 230, xxxi.
—— on Waterspouts on the coast of N. S. Wales 132, xviii.
—— P. N., Scholarship ... 40

S

Seaweeds, olive-green 169, xv., xxv.
Section, Engineering, meetings in 1897 10
—— Medical, meetings in 1897 10
Selfe, Norman, M. Inst. C. E., etc., Some notes on a wharf recently built in deep water at Dawes Point, Sydney, New South Wales ... LXIV.
Sewerage, purification of ... 16
—— of Sydney, low level ... 18

Digitized by Google

PAGE
Silver nuggets, sections of ... xxi.
Smith, Henry G., F.C.S., on The Pinenes of the oils of the genus Eucalyptus, Part 1 195, xxix.
—— and Baker, R. T., F.L.S., on The Stringybark trees of N. S. Wales, especially in regard to their Essential Oils 104, xiii.
Soaring machines ... 209, xxxv.
Stalactites xxi.
Stalagmites xxi.
Stentor cæruleus 266
Stormwater drainage ... LVII.
"Stringybark" trees of New South Wales ... 104, xiii.
Stuart, Prof. Anderson, M.D., Model demonstrating the action of the auditory ossicles xix.
Sydney City Railway v.
—— Sewerage VII.

T

Tablet on Inscription Point, Botany Bay... xv.
Technical College 39
—— Training 48
Telegraphs and Telephones ... 19
Terebinthene 199
Testing machine for equal alternating stresses ... CVIII.
'Thetis' Trawling Cruise ... 38
Threlfall, Prof., departure of xxxvi.
—— Notes on matters connected with Engineering in England lxiii.
Tumba (the) ceremony ... 247
Turacin 267

V

Vocabulary, native ... 238, xxxv.
Voluta mamilla 35

W

Warren, Prof. W. H., Wh. Sc., M. Inst. C.E., on A testing machine for equal alternating stresses CVIII.
—— and Barraclough, S. H., M.M.E., Assoc. M. Inst. C.E., on Some physical properties of nickel steel 150, xix.
Waste products, utilization of XVIII.
Water Conservation in N.S.W. 30
Water-spouts on the coast of New South Wales ... 132, xviii.
Wharf in deep water ... LXIV.
"White Stringybark"... 105, 106

Digitized by Google

Sydney:
F. W. White, Printer, 39 Market Street.

1899.

Digitized by Google

Digitized by Google

CONTENTS.

PAGE.

ART. XVI.—The Blue Pigment of Corals. By Professor Liversidge, M.A., LL.D., F.R.S.... 256

ART. XVII.—Annual Address to the Engineering Section. By T. H. Houghton, Assoc. M. Inst. C.E., M. Inst. M.E. I.

ART. XVIII.—The Narrow Gauge as applied to Branch Railways in N.S. Wales. By C. O. Burge, M. Inst. C.E. XXII.

ART. XIX.—Engineering Construction in connection with Rainfall. By J. I. Haycroft, M. Inst. C.E. I., Assoc. M. Am. Soc. C.E. ... XXXIII.

ART. XX.—Some Notes on a Wharf recently built in deep water at Dawes' Point, Sydney, N. S. Wales. By Norman Selfe, M. Inst. C.E., &c. LXIV.

ART. XXI.—Notes on Hydraulic Boring Apparatus. By G. H. Halligan, C.E. LXXII.

ART. XXII.—Lighthouses in N. S. Wales. By H. R. Carleton, M. Inst. C.E. LXXXII.

ART. XXIII.—A Testing Machine for equal alternating stresses. By Professor Warren, Wh. Sc., M. Inst. C.E. CVIII.

ABSTRACT OF PROCEEDINGS i.

PROCEEDINGS OF THE ENGINEERING SECTION... lx.

PROCEEDINGS OF THE MEDICAL SECTION lxiv.

INDEX TO VOLUME XXXII. (xxvii.)

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

3 2044 106 281 173

Digitized by Google